Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XXXIX. No. 16. NEW YORK, SATURDAY, OCTOBER 19, 1901. ISSUED WEEKLY.

ELECTRICAL REVIEW
PARK ROW BUILDING
13-21 PARK ROW - - NEW YORK
P. O. BOX 339

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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to insure publication in that week's issue.

The collapse of the liquid air company which started under such well advertised auspices in New York a year or more ago will recall the warnings which have appeared in these columns regarding the attempt to capitalize the perpetual motion industry. Liquid air is a curious and interesting product of the physical laboratory, and as such is entitled to recognition. It was demonstrated over and over again, during the days when the exploiting company was selling its stock to gullible individuals, that liquid air possessed no advantages either as a motive power or as a refrigerant which could make it a possible competitor of other agencies. When its promoters made the astonishing claim that through the agency of this remarkable fluid perpetual motion and the generation of a continuous supply of energy were possible, the subject was promptly dropped from the consideration of the responsible press and only the fanatic few, ever looking for opportunities to make quick wealth, paid any attention to these claims. They have reaped the usual reward, and it is hoped that their experience may act as a deterrent to others in case a similar scheme is again floated.

THE ELECTRIC STREET RAILWAY.

The convention of the American Street Railway Association, which was held last week in New York, brought out in strong relief some of the features of the modern street railroad. The convention and the exhibits connected with it formed an imposing object lesson of the magnitude of the industry which has succeeded the omnibus of our forefathers and the horse-car of our earlier recollections.

In one of the papers presented at the convention—that by Mr. Robert McCulloch, which is republished in another place in this issue—an entertaining history is given of the rise and development of the street railway in the United States. There is hardly any subject that is of more interest to the student of social conditions than the various determining causes which have led street railway enterprises to their present position of high prominence, and the curiously subtle reactions which have taken place between the conditions of municipal life in general and the means of city transit.

It is fair to say that the real history of the street railroad as an important factor in municipal conditions begins fourteen years ago, with the first successful commercial application of electricity to the operation of street cars. The increasing size of cities and the consequent condensation of population in their busier parts caused, in the earlier decades of the past century, the introduction of omnibuses as convenient and cheap means of transit from place to place. The omnibus became the poor man's vehicle and, as the poor man forms the numerical majority of the population, it became exceedingly popular; and its business so enlarged and increased that it was determined, some forty years ago, to try the experiment of operating omnibuses upon tram rails in order both to ensure smooth traction and to permit greater loads to be hauled by the animals then employed for traction purposes. Probably the earliest street railway was that laid by the late John Stephenson in the Fourth Avenue, New York city. Vehicles employed upon it were, to all intents and purposes, the omnibuses then in general use, running on light metallic flanged wheels, and the track consisted of strap-iron laid on wooden stringers. It was an immediate and overwhelming success, and a considerable industry in the manufacture of street cars and the equipment of horse-car lines took its rise from this initial experiment. By the year 1887 every place of any considerable size in the United States was supplied with one or more horse-car lines, while cities such as Boston, New York and Philadelphia had many miles of them.

Just as the pressure of public necessity had caused the evolution of the street car from the omnibus, so the increasing need for more rapid and efficient methods of transit compelled the search for a better motive power than the horse or the mule. In some suburban lines, at about this period, steam "dummy" locomotives were used, and a great number of tentative experiments were made with a variety of motors, but none seemed to be entirely satisfactory except the moving cable running in a conduit under the track. In certain cities this system was installed, and notwithstanding its enormous cost, high depreciation and exceedingly low efficiency, it earned money on lines where travel was dense. In a few years after the introduction of the cable system such cities as San Francisco, Chicago, Philadelphia, Baltimore, St. Paul, New York and others had installed it and given the public in those places their first taste of the benefits of increased speed from mechanical traction.

But, great as were the merits of the cable compared with the horse-car, its general extension was out of the question on account of the severe limits imposed

upon it by high cost, lack of flexibility and expense of operation. Something better was urgently demanded and was at last found in the electric motor.

The history of the application of electricity to street railways is too familiar and too recent to need recounting here, but it is worth while to dwell upon certain features of the evolution of the modern street railway system as an indication of the tendencies which will control the future extension of similar lines.

For city use—that is, for lines wholly within the corporate limits of cities—it seems safe to say that the modern electric car and its equipment have about reached the limit of their development. Speeds are as high as can be safely maintained in traveled streets, the cars are comfortable to a degree that would have astonished the pioneers in street railroading, and the economy both of installation and operation of such lines has reached a point not very far from the probable limit imposed by natural conditions. Methods of power generation and distribution have been perfected until their efficiency approaches the absolute. The street railway motor has been standardized and has become one of the most reliable, simple and satisfactory pieces of machinery with which engineers are familiar. Difficult and vexatious questions of track construction and of conduit construction have been satisfactorily solved, and the industry of operating street railroads in cities has become entirely stable. But the street railway in its extension beyond cities and into rural districts has undergone a transformation which appears to be simply an index of what may be expected in its future development.

Immediately upon the electrification of city lines came the natural extension of such lines into suburban districts and then, as the apparatus employed was perfected, their further extension to neighboring towns, forming interurban lines as distinguished from those lying entirely within the confines of a single municipality. The general progress of electrical engineering made the length of line that could be satisfactorily operated from a single station greater and greater, until lines were built of such respectable extent as to rival steam railways of moderate length. The extraordinary flexibility and cheapness of electric railway construction led to the building of a network of lines which, in the last ten years, has spread itself over certain parts of the United States until it rivals in extent the steam railway systems and has built up a new source of prosperity in the short-haul, passenger-carrying business.

At first such interurban lines were constructed somewhat after the manner of the city lines, using light tracks and operating cars of the same general pattern as those used in cities, which themselves were simply an evolution of the horse-car of a previous decade. But it was soon found that the conditions of cross-country railroading demanded, in the first place, better tracks, and, in the second, larger cars and higher speeds. As a consequence there are being built to-day large numbers of such railways which compare in all respects with the standard steam railroad construction, and upon which cars of large size and great weight are operated at higher speeds than were customary on steam railroads a generation ago. And to this extension there appears to be no limit placed by the engineering conditions entering into the problem presented.

Many electrical engineers have looked and longed for the time when electrical equipment would replace the steam locomotive in a large degree upon main line railways. Under the pressure of necessity there has been constantly growing a network of light railways, gradually improving in character and becoming more and more like their rivals, the steam railroads, until to-day the question of electrification of the main line roads finds itself on the point of being solved, but in a way little thought of by those who originally considered the question. A new group of railways of a new kind has grown up, using electric traction and competing in the open market for business, both passenger and freight, with existing steam lines. How soon this competition will force the electrification of steam railroads, or whether the two types will remain coexistent with one another, dividing the general business of transportation in accordance with their respective facilities, is a question that can hardly be answered at this date; but no one fact is more certain than that, just as the electric street railroad was developed out of the horse-car, which, in turn, was the evolution of the omnibus, so the high-speed, long-distance electric railway is the goal to which the evolution of the electric street railway is tending.

Few electricians realize how great is the demand for an electric lamp of moderate candle-power that can burn on low frequency. It seems likely that, if the ordinary incandescent lamp would work satisfactorily on twenty-five cycles per second, that figure would become almost the standard of frequency for alternating-current distribution in a large majority of cases. As it is, the incandescent lamp has set the limit of frequency in many installations and caused a considerable sacrifice of convenience in other respects by its requirements concerning the periodicity of the current supplied for it. One of the principal advantages which may be claimed for the Nernst lamp and others of its class is that these translating devices will work satisfactorily on very low frequencies. Lamps of the ordinary type working at low voltage and low efficiency show no appreciable flutter at twenty-five cycles, but high-voltage lamps are practically impossible at this frequency and some eyes are disturbed by them at thirty cycles. The fact of its operation on low frequency is one that will doubtless greatly assist the Nernst lamp in securing a commercial foothold.

Few realize what gigantic proportions the construction of electric railways in the United States has now reached. During the last twelve years, twenty-one thousand miles of electrically operated railways have been completed in the United States alone—enough to extend nearly around the earth. For this work nearly a billion of dollars has been expended, which shows to what astonishing limits this application of electricity has been carried. And it should be remembered that this is only the beginning of an industrial development scarcely yet out of the swaddling clothes of its infancy.

AUTOMATIC TELEPHONE EXCHANGES.

Occasion was taken in these columns some weeks ago to refer to the fact, long known among telephone men, that most of the trouble incident to the operation of telephone exchanges is due to the carelessness of the public and their lack of cooperation with the exchange force to produce the best results. If one calls for a telephone connection in the average exchange and does not get it within a few seconds his wrath is generally directed toward the exchange management, whereas the person called may have neglected to answer his call promptly and be really responsible for the delay. The neglect of this important matter—the prompt answering of telephone calls—fairly lies at the bottom of a great deal of the criticism which has been directed in the press and generally toward telephone exchange management.

Of late years there has been considerable work in the direction of establishing automatic telephone exchanges, in which the functions of the operator are entirely suppressed, the public themselves being their own operators through the agency of certain automatic apparatus grouped at a central point. It will be very interesting in noting the extension of such systems to observe their effect upon the public mind and temper. With automatic apparatus each person perfects his own call and is certain of the moment at which the called subscriber's bell rings. The automatic exchange, being simply a collection of obedient and instantaneously acting machinery, enjoys the same immunity that is supposed to protect corporations who have "neither souls to damn nor bodies to kick." In such exchanges, therefore, delays in obtaining through connections will be promptly ascribed to their real causes.

Seriously speaking, the automatic system, assuming that such a system can be made entirely satisfactory in the matter of giving through connections or indications of busy line, possesses certain very important advantages over any exchange in which there is the human element. For one thing, communications through it are absolutely private; in the second place its educational effect upon users of the telephone will doubtless greatly quicken and improve the service, and in the third place, the public morals will certainly be bettered by a system which brings home to every man his own mistake in getting the right connection. There has been far too much abuse heaped upon the telephone operator. It will be very interesting to see what will be said of telephone operators which are partly mechanical and which are controlled by the subscribers themselves.

A WORD TO THE ARCHITECT.

In these days, when practically every building of any pretensions whatever that is erected is wired during its construction for electric lights, it is well to note that one of the most essential conveniences of electric lighting is an abundance of outlets. While the electric light is superior to gas and other illuminants in very many respects, one of its most marked conveniences is its instantaneous radiance at the touch of a switch, no matches or other auxiliaries being requisite to illuminate it. This convenience, however, is in a large measure lost when a building is so wired that only a limited number of lamps are available and where dark corners and rooms exist in which it is necessary, when a light is wanted, to carry one in the hand or else use the objectionable match. The average residence which is wired for electric light often has large closets, perhaps unfinished attic rooms, spaces in the cellar, etc., where there is no outlet for the electric wiring, and in which once in a while a light is needed. When the light is needed in such places it is generally needed very much, and there is no resource left to the householder but the employment of the candle, kerosene lamp or match, as the case may be, all of which are distinctly dangerous, especially in such places. In the construction of a house the wiring is not a large item of expense, and the addition of sufficient outlets in places such as are mentioned above would add so little to the cost as to be entirely inconsiderable. At the same time, the presence of electric lamps in such dark corners would be an element of insurance against fire of considerable importance, and a convenience which every householder would highly appreciate. It goes without saying that it would add nothing to the cost of lighting, because such lights are used only rarely and occasionally. The subject is one that is well worth the attention of builders and architects, as well as of those who are planning the erection of buildings.

It is hard to realize how dependent we all are upon one or the other of the numerous applications of electricity. If, however, we could imagine all of the electrical services of a great city like New York suddenly to stop the condition into which the inhabitants would be instantly thrown would be as serious as it would be laughable. In New York, for example, the occasional horse-car line would be the only means of transit in operation except the steam elevated trains, and there would be an outpouring of people from cellars and inside rooms where artificial daylight of the electrical variety is the only sort known. The business world would come to a sudden and violent stop because of the cessation of the telephone and the exchanges would go into wild panic through the stoppage of their telegraph and telephone facilities. A conflagration might break out and sweep a large section of the city before news of it could reach the department by messengers on foot or in the horse-car. A practical paralysis would seize the community and would precipitate practically a state of anarchy. It is only by trying some such picture as this that we can begin to understand the enormous importance of the electrical service of a metropolitan community and the important part that electricity plays in the daily life of the people. It is no exaggeration to say that a stoppage of the electrical services of New York for ten minutes would be a serious and far-reaching calamity.

It is gratifying to notice that the general business conditions of the country are superb and that every indication still points to a continuance of the extraordinary prosperity which has marked the last two years. Matters in the business world in general have been moving somewhat slowly for a month or more on account of the prolonged heat of the summer season and the natural unsettlement and grief of the community at the assassination of President McKinley. Now that the fall weather has set in and the community has had time to recover from the shock of the great calamity a vigorous resumption of business is noticeable on all sides and every indication leads to the belief that the winter of 1901-1902 will be one of the most active and successful seasons that has ever been known, both in the electrical trades and in general.

Science Brevities

Metallic Niobium — Moissan has lately obtained this hitherto little known metal in considerable quantity by means of the electric furnace, from American columbite or niobite, a mineral containing niobic and tantalic acids, says a British contemporary. The metals are reduced together by carbon, dissolved and the niobic acid separated as a snow white powder, which is again reduced by carbon with a current of 600 amperes at 50 volts into an ingot containing two or three per cent carbon, but otherwise pure. It scratches glass and quartz, is infusible in the oxyhydrogen flame, but melts easily in the electric furnace, does not decompose water at a red heat, is almost unattacked by acids, but dissolves in mixed nitric and hydrofluoric. Chlorine, bromine and fluorine form haloid salts like the chlorine, $NbCl_5$. Powdered nobium, when heated, burns brilliantly in oxygen and combines with nitrogen. It does not readily form alloys. Several other reactions indicate relationship to boron and silicon.

New Accumulators—Some descriptions of new accumulators are given in *L'Eclairage Electrique* and digested in a London contemporary. The Loppé-Morin, English patent 20,110, September, 1900, has thin lead plates perforated and pasted in a peculiar manner to allow of free circulation of the electrolyte. The Lugard (22,143, October, 1900) retains the peroxide of lead by strong ribs on the plates. Wiegaud's arrangement (10,318, August, 1900) is a species of Volta's pile of superimposed basins with red lead as the positive and litharge as the negative face, with asbestos cloth and a layer of carbon, charged with a liquid electrolyte; the basins are insulated from one another by a non-conducting liquid. McRae's (13,095, October, 1900) is a lead grid strengthened by enclosed bars of copper or aluminum which also furnish better connection. Bowker (15,710, October, 1900) has an electrode in the shape of a rectangular lead box enclosing a perforated plate charged with the active material. In Goldstein's patent (17,410, June, 1900) the transverse section of the metal ribs of the positive electrode is in the form of a cross filled in with the charging substance so as to make square bars. Von Seineff, Berlin, Eng. patent 12,531, 1900: positive electrode for accumulators. The support consists of lead plates placed crosswise or radially and having their interspaces filled with active materials, the flat sides of the lead plates having longitudinal ribs "in such a manner that in cross-section the electrode frame has approximately the shape of branches of fir placed crosswise for giving the electrode support a large surface while using the smallest possible amount of material and for providing equal supply of current." W. B. Bary's system realizes a very large active surface by stamping rings of lead 0.5 millimetre in thickness, curved into a gutter form, stacking them over one another at one millimetre distance, and soldering to longitudinal ribs. It is said to be difficult to maintain regular intervals between the poles. A table of the efficiencies of this system under different conditions is given, and an article by E. Abel on the theory of the accumulator battery.

Conductivity of Solution in Liquefied Ammonia—That liquefied ammonia gas, NH_3, and some other liquefied gases, such as cyanogen, while comparatively inert at the low temperature in ordinary chemical reactions, possessed remarkable solvent powers on elements and salts, was discovered many years ago by Gore, who suggested that these liquids, notably the blue solutions of the alkali metals, Na and K, in NH_3, ought to exhibit significant electrical and chemical properties, which might be of economic use, says *Lightning*. E. Legrand (*Éclair. Electrique*, xxvi, 88) has recorded the results of a number of experiments on these solutions. He comes to the unexpected conclusion that the conduction with the solutions of metallic sodium in liquefied ammonia is probably electrolytic, since, although the current passes without any marked deposition on the electrodes, without liberation of gas, and with only slight signs of polarization, yet the conductivity increases with the temperature. He has also determined the conductivities of a number of chlorides, iodides, nitrates and other salts in solution in NH_3, by passing a current in series with a megohm resistance, and comparing the P.D. at the terminals of the resistance with that near the electrodes. The resistances showed positive temperature coefficients similar to those with aqueous solutions at 51 degrees centigrade. The molecular conductivities did not tend to reach a limiting value with increase of dilution, and could not be expressed as the sum of the conductivities of two ions. The conductivity of mixtures of NH_3 and water at — 30 degrees centigrade were also determined.

Hertzian Waves in Thunder-storms—The influence which thunder-storms exercise at a distance of thousands of miles upon persons affected by certain nervous diseases, long before any physical instrument announces an atmospheric disturbance, suggested to F. Larroque that Hertzian waves emitted by thunder-storms might possibly be propagated over enormous distances through the middle and higher atmosphere by means of something corresponding to relays. He, therefore, constructed an elementary kind of "receiver" in the shape of a horizontal plate of zinc, forty cm. in diameter, earthed by a thin copper wire containing a spark-gap in a dark cellar. During the great atmospheric disturbances of June, 1901, several series of nocturnal observations were made, the results of which have been published in the *Comptes Rendus* and digested in E. E. Fournier D'Albe's abstracts. One of them coincided with the blizzard in the Grampians, and the other was carried out during a thunderstorm which, in the night of June 18, was visible over Corsica from the Département des Alpes Maritimes. In both cases the sky was serene at the place of observation. The author points out the great importance which this kind of meteorology may acquire, without, however, venturing an explanation of the actual transmission of Hertzian waves over the enormous distances specified.

The Effect of Amalgamated Gases on Resistance—A communication from William Rollins on this subject has been published in the *American Journal of Science*. As the result of experiments with X-light tubes, I concluded that we depend on gases amalgamated with the terminals of a vacuum tube for an efficient cathode stream for producing X-light. It, therefore, seems desirable to see if the partial removal of these gases would in any way change the resistance of the metal forming the terminals. Spiral terminals were made, the ends of each spiral being brought to the outside of the tube so that a current could be sent through the spirals before the X-light tube was pumped and after as much gas as possible had been removed from the metal by heat, electricity and pumping. Mr. Oelling and Mr. Heinze constructed the tubes and made the tests during the summer of 1900. They reported that the resistance of a wire was increased by removing the amalgamated gases. In one experiment the resistance of the wire forming a spiral terminal in an X-light tube was 0.068 of an ohm before and 0.080 after. The instruments for making the experi-

ments were not of a high grade. On this account the results were not reported, as I hoped to repeat the experiments with better apparatus and with terminals made of all the common metals. As this opportunity has not come, I now report the experiments that some one better equipped may extend them.

Induced Radio-Activity Produced by Salts of Radium—An interesting series of experiments has been made by P. Curie and A. Debierne, an account of which has been published in the *Comptes Rendus* and abstracted in the *American Journal of Science*. These experiments show that radio-activity is transmitted in the air through short distances and induces activity in other substances. This induced activity is much more intense when it is produced in completely closed vessels than when the action takes place in the open air. A radiferous substance was placed in a small open bulb in a closed vessel, and plates of various substances (lead, copper, aluminum, glass, ebonite, card, paraffin, all of which appear to be acted on in about the same manner) were placed in various positions in the vessel, and in all positions, even behind a lead screen, they became active to about the same extent after a day's exposure, provided that the air of the vessel had free access to their surfaces. A plate resting on the bottom of the vessel became active only on its exposed surface. With very active barium chloride (radium), plates exposed for several days in this way attained an activity 8,000 times greater than a plate of metallic uranium of the same dimensions. When exposed to the free air, the plates lose the greater part of their activity in a day, but the activity disappears much more slowly when the plates are left in a closed vessel after the active substance has been removed. If the experiment is made with the bulb containing the active substance completely closed, no induced activity is obtained. Other experiments showed that this induction is rapidly carried through capillary tubes connecting small closed spaces. It was found that the action is progressive, finally reaching a limit which depends upon the activity of the active body. The action is more rapid the smaller the vessel containing the bodies. These phenomena have been observed with various salts of active barium, such as the chloride, sulphate and carbonate. Salts of actinium also produce induced activity, but, on the other hand, salts of polonium, even when very active, produce no such effect The authors believe that this circumstance may have a connection with the fact that polonium does not emit rays that are deviated by the magnetic field. In a subsequent communication the same authors state that water can be rendered radio-active either by distilling it from a solution of radium chloride in an air-tight vessel, by placing a dish of water in a closed space containing a solution of radium salt or also by enclosing a solution of a radium salt in a hermetically closed celluloid capsule and plunging the latter into distilled water in a closed vessel. In the last case, no trace of the salt passes into the water, but the activity of the solution is to a great extent communicated to it. This induced activity can not be transmitted by air through a wall of dry celluloid, but it passes easily if the wall is wet with a drop of water. Water can be rendered very strongly active, but when kept in a sealed tube it loses the greater part of its activity in a few days. When kept in an open vessel the water loses its activity much more rapidly, the loss being the more rapid the greater the surface exposed to the air. Solutions of radium salts in open vessels behave in the same way as the water just mentioned, but in this case the loss of activity is not absolute, for if such a solution is put into a sealed tube it gradually acquires its original activity in the course of ten days or so. The authors look upon radio-activity as being analogous to heat in being dissipated by radiation and by conduction. In the latter case it passes through gases and liquids, but not through solids. If a solid radio-active body is left free to the air, its activity does not diminish sensibly, and the authors have shown that a solution of a salt produces much more intense phenomena of induced radio-activity (twenty times greater) than the solid salt itself. When the salt has been in solution several days, the radio-active energy is divided between the salt and the water, and if the latter be then distilled off, it contains a great part of the activity, while the solid salt is much less active (ten or fifteen times, for example) than before solution. When left to itself the solid salt regains, little by little, its original activity. The communication of the activity of a radium salt to its water of solution is very slow, and equilibrium is obtained only after about ten days.

A New Alloy—Magnalium—Magnalium is an alloy of magnesium and aluminum, specific gravity between 2 and 3, melting point 600 to 700 degrees centigrade. When increasing quantities of magnesium are added to aluminum, the resulting product gradually changes from the comparatively soft and unworkable metal to a harder and harder metal, and with the quantities of magnesium varying from five to thirty per cent, the alloy is similar in qualities to brass and bronze. When the proportion of magnesium is increased to fifty per cent, the alloy ceases to be useful for mechanical purposes, but is then capable of taking a high polish, and is eminently suitable for optical use. At above fifty per cent magnesium, the alloy approaches in properties to magnesium, and loses its hardness. As regards durability, the alloy containing from tweny-five to thirty per cent of magnesium is somewhat superior to aluminum, and retains a bright polish for a great length of time. Magnalium may be coined easily, being much superior to aluminum in this respect, and almost approaching nickel. Screws and nuts can be made of it, which is not the case with aluminum. The tensile strength of plates containing five per cent magnesium is about thirteen tons per square inch.

Electrolytic Chromium—With a divided cell containing a chromic salt at the cathode and an acid or saline solution at the anode, good deposits of chromium can be obtained on a carbon cathode, or on platinum, brass, lead, etc., according to the experiments of Neumann, which were published in *Zeitschrift für Elektrochemie,* and abstracted in a London journal. With chromic chloride solutions containing 10 per cent Cr, a current density per square decimetre of 0.9 ampere gave only oxide, 1.8 to 7.2 amperes gave oxide and metal, 9 to 18 gave pure metal, in the latter case mostly crystalline, with a current efficiency in densities 9 and upward of about 38 per cent. Increase of temperature hardly affects the current efficiency, but above 50 degrees centigrade the metal deposits as a black powder. A strength of 16 per cent Cr in the solution gives a yield of 57 per cent, increased to 89.5 by altering the anode solution. With chromic sulphate the best conditions are 6.5 to 8.5 per cent Cr and 13 to 23 amperes per square decimetre, giving 84.6 to 86 per cent efficiency. Acetate does not work well. The deposits are bright gray and lustrous, but have a tendency to peel off, due to films of oxide. They are hard and brittle and very pure, containing only 0.1 to 0.2 per cent of iron, and, like ordinary chromium, occur both in active and passive states. The decomposition potential in chromic sulphate of five times normal strength is 1.898 volts, in the chloride 8 times normal 1.685 volts, but it is necessary to use at least double this electromotive force.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XLVI.

BY W. ELWELL GOLDSBOROUGH.

Reviewing Fig. 114, which shows only the final vectors of Fig. 113, we find that even under the conditions of commercial working, a two-phase, three-wire system does not produce entirely balanced conditions in receiving circuits, however carefully a system may have been laid out to secure this end. Although the generator electro-motive forces are equal and differ in phase by an angle of exactly 90 degrees, Fig. 114 shows that the receiver impressed electro-motive forces OA_4 and OA_6 are not equal and differ by an angle that is greater than 90 degrees. Further than this, the receiver currents OB_1 and OB_3 are not equal, and their phase difference is also greater than 90 degrees.

The current flowing in the common return circuit O′O is, in this case, much greater than that shown in the explanatory diagram of Fig. 102, and, therefore, represents in its magnitude a current approximately equal to the square root of the sum of the squares of the currents in the outside lines. In ordinary commercial practice, it is common to assume that the current flowing in the common return on a two-phase, three-wire system is equal to the square root of the sum of the squares of the two outside line currents, on the assumption that the outside currents differ in phase by exactly 90 degrees. Fig. 114 shows, however, that this condition can never be exactly attained in practice, as the outside line currents do not differ exactly by 90 degrees, and are, moreover, not equal in value to the current vectors, of which the current in the common return wire is the resultant. A careful inspection of Fig. 113 shows that $O'B_2$ is the resultant of the vectors $O'B_2^{I}$ and $O'B_2^{III}$, which *are* at right angles to one another and which, moreover, are *equal* in value. Now, were it possible to eliminate the two small currents $O'B_3^{I}$ and $O'B_1^{III}$, the vector OB_1 of Fig. 114 would reduce to the vector $O'B_2^{I}$ of Fig. 113 and the vector OB_3 of Fig. 114 would reduce to the vector $O'B_2^{III}$ of Fig. 113. In this event, therefore, OB_2, the current flowing in O′O, would accurately represent the square root of the sum of the squares of the two outside circuits. Now, as the line losses in the distributing lines are reduced, the apparent resistances of the receiving circuits become greater and greater relatively to the resistances of the lines; consequently, as the line losses become smaller, the vectors $O'B_3^{I}$ and $O'B_1^{III}$ diminish in length, since, relatively to the resistance of the circuit O′O of the parallel circuits in the initial diagram of Fig. 112, the resistances of the series circuits $O'A_1A_4O$ and $O'A_3A_6O$ increase as the resistances of the line circuits A_1A_4, O′O and A_3A_6 are reduced. We find, then, that in practice, where line losses are kept down to within five or ten per cent of the total power delivered by the generator, the distributing two-phase, three-wire system is practically a balanced system. Under these conditions, the point A_4 approaches nearer to the point A^{I}, the point A_6 approaches nearer the point A^{III}, and O more nearly coincides with O′; consequently, as the line losses are reduced, OA_4 approaches $O'A^{I}$ both in value and phase position as a limit, and OA_6 approaches $O'A^{III}$ both in value and phase position as a limit. Theoretically, therefore, when the line resistances become negligible, OA_4 and $O'A^{I}$ will coincide, and OA_6 and $O'A^{III}$ will coincide.

Further than this, in practice it is customary to make the cross-section of the common return circuit O′O greater than the cross-section of either of the outside lines. Consequently, the total impedance of this circuit will be less than the impedance of either of the outside lines, with the result that the point O will be drawn toward the point O′. This has the effect of bringing OA_4 more nearly parallel to $O'A^{I}$, and OA_6 more nearly parallel to $O'A^{III}$.

This discussion has disclosed the fact that, while in reality, two-phase, three-wire systems can never be entirely balanced, they, nevertheless, in so far as all practical requirements are concerned, constitute systems of working which may be assumed to be balanced. In general commercial working, therefore, the following rule applies, to wit: *The current flowing in a common return of a two-phase, three-wire system is equal to the square root of the mean square of the currents flowing in the outside lines.*

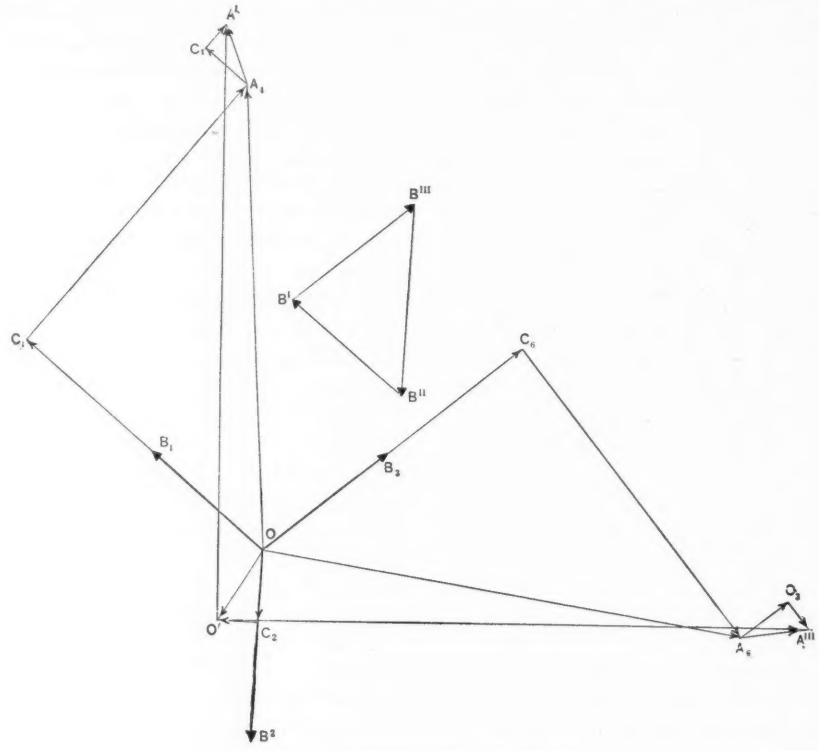


FIG. 114—ALTERNATING MECHANISMS.

TREATMENT OF COMMERCIAL, THREE-WIRE DISTRIBUTING SYSTEMS.

In the practical distribution of electrical energy by means of three-phase currents, there are two prominent systems of connections. One of these, that shown in Fig. 116, is technically known as the *star* connected system. The three receiving circuits, OA_4, OA_5 and OA_6, have their inner leads connected together, and their outer leads connected directly to supply mains, A_1A_4, A_2A_5 and A_3A_6, respectively. To all intents and purposes, this system is identical with that already discussed in connection with Fig. 104. In Fig. 116, a diagrammatical modification is made by arranging the three receiving circuits in *star* form and separating the line impedances from the receiver impedances. The dotted connection shown in Fig. 116 between the points O′ and O is one which is sometimes used, and is known as the *neutral wire*. When a star connected system is

perfectly balanced, there will be zero difference of potential between the points O′ and O. This fact has been already pointed out in the discussion of Fig. 104, p. 149, where it was shown that, under perfectly balanced conditions, the vector

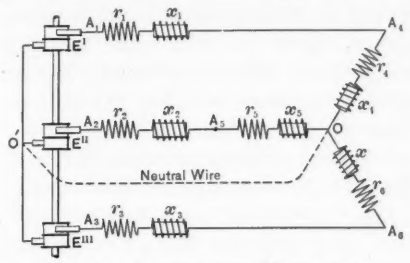


FIG. 116.—ALTERNATING MECHANISMS.

centres O′ and O of Fig. 109, p. 207, coincide (as in Fig. 110, p. 239).

In case a star connected system is unbalanced, the neutral connection is no longer inert, but is influenced by an impressed electro-motive force having a value equal to the vector distance between the points O′ and O of the phase diagram of Fig. 109. As soon as the neutral circuit of an unbalanced three-phase system is closed, the flow of current in the neutral circuit tends to bring the points O′ and O to the same potential. In other words, the neutral wire plays the part of a bipass for the excess current in the most heavily loaded of the three arms, and thereby, by bringing the points O and O of Fig. 109 closer together, causes a more even distribution of potential over the system. The neutral wire is then an important factor in three-phase work, where the conditions, which are locally imposed, make it relatively impossible to maintain a well balanced distribution system.

In Fig. 117 is diagrammatically shown what is commonly known as a mesh connected, three-phase system. Here the terminal leads of each of the receiving elements are connected directly to the distributing lines. The three-phase mesh diagram gives us a *triangular* arrangement of the receiver circuits, and impresses at the terminals of each of the receiver circuits an electro-motive force equal to the potential between the distribution lines; in other words, it impresses upon the receivers electro-motive forces represented (for instance, in Fig. 109) by the vector distances $A^{I}A^{II}$, $A^{II}A^{III}$ and $A^{III}A^{I}$.

In a mesh system of connections it is impossible to make use of such a neutral circuit as that shown in Fig. 116. Furthermore, the mesh connection results in a greater potential being maintained at the terminals of the receivers than is maintained in a star connected system where the potential between the outside mains is the same for both. If we assume that, in Figs. 116 and 117, the generator electro-motive forces are all equal and that the line constants are also all equal, when a given amount of energy is being distributed at a given power factor, the potential between the points A_7 and A_8 of Fig. 116 will equal the potential between the terminal points A_7 and A_8 of Fig. 117, and this equality will also exist among the pressures between the two remaining sets of terminals. This makes it apparent that it is possible to replace a star connected system of receivers by an equivalent mesh connected system. This is a consideration which must be kept in mind, as it is often a potent factor in the arrangement of complex three-phase systems.

It is not necessary that a perfect balance should be maintained, as has just been implied, in order that the substitution of a mesh connected set of receivers for a star connected set of receivers can be made. That this is true is evidenced by

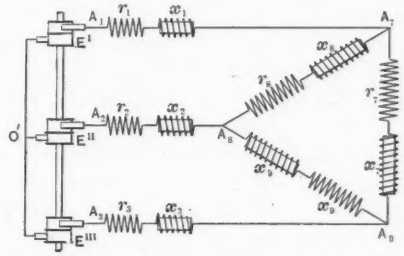


FIG. 117.—ALTERNATING MECHANISMS.

the phase diagram presented in Fig. 118. Here the vector OA_{4-7} represents the potential impressed upon the circuit OA_4 of Fig. 116, the vector OA_{5-8} the potential impressed upon the circuit OA_5 and the vector OA_{6-9} the potential impressed upon the circuit OA_6.

Now, in the circuit OA_4

$$r_4 = 20.2 \text{ and } x_4 = 11.6.$$

In the circuit OA_5

$$r_5 = 22.4 \text{ and } x_5 = 6.5.$$

In the circuit OA_6

$$r_6 = 16.5 \text{ and } x_6 = 7.7.$$

Further, the potential impressed on the circuit OA_4 is 1,050 volts; on the circuit OA_5, 1,100, and on the circuit OA_6, 1,000 volts. We will therefore have 45 amperes flowing in the circuit OA_4, which lags 30 degrees behind the electro-motive force OA_{4-7}.

In the circuit OA_5 a current of 47 amperes will flow, and lag 16° behind the vector OA_{5-8}.

And, in the last circuit, a current of 55 amperes will flow, which will lag 15° behind the impressed electro-motive force OA_{6-9}.

From this diagram we see, therefore, that the following amounts of power are delivered to the several "star" receiving circuits:

OA_4 receives 4,090 watts.
OA_5 receives 4,949 watts, and
OA_6 receives 5,028 watts.

This makes a total of 14,067 watts.

Now, in the case of the mesh connected receivers in the circuit

A_7A_9, $r_7 = 15$ ohms and $x_7 = 31.5$ ohms.
In A_8A_7, $r_8 = 69.8$ ohms and $x_8 = 20.4$ ohms.
In A_9A_8, $r_9 = 56.7$ ohms and $x_9 = 17.1$ ohms.

More than this, by measuring off the potential differences, we find that

1,774 volts are impressed on the circuit A_7A_9,
1,862 volts are impressed on the circuit A_8A_7, and
1,813 volts are impressed on the circuit A_9A_8.

Therefore,

a current of 29.6 amperes flows through the circuit A_7A_9, and lags 31.7° behind the vector $A_{4-7}A_{6-9}$;
26.4 amperes flows in the circuit A_8A_7, and lags 22.9° behind the vector $A_{5-8}A_{4-7}$; and
30.6 amperes flows in the circuit A_9A_8, and lags 16.9° behind the vector $A_{6-9}A_{5-8}$.

Therefore,

the circuit A_7A_9 receives 4,470 watts,
the circuit A_8A_7 receives 4,222 watts, and
the circuit A_9A_8 receives 5,314 watts,
which is a total of 14,006 watts.

In other words, the mesh connected system of receivers absorbs the same amount of power as the star connected system of receivers, and it is equivalent in every respect, since the electro-motive forces impressed at the terminals of the mesh connected circuits are equal to the vector

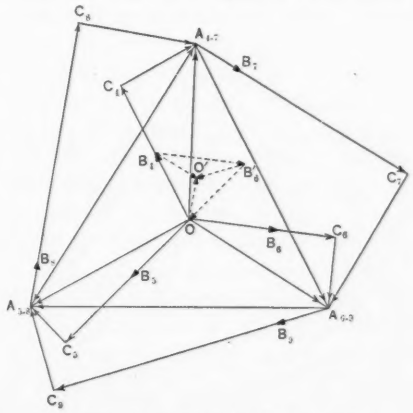


FIG. 118.—ALTERNATING MECHANISMS.

resultants of the electro-motive forces impressed at the terminals of the star connected circuits, and the currents flowing in the mesh connected circuits are the vector resultants of the currents flowing in the star connected circuits. That these statements are exact, the electro-motive-force vectors already discussed plainly show, in-so-far as the electro-motive forces are concerned; and the small vector diagram OB_4B_6' proves the statement as regards the current vectors. In this diagram B_4B_6' is equal and parallel to OB_6 and $B_6'O$ is equal to OB_5. Further, B_4O' is equal and parallel to $A_{4-7}B_7$, OO' is equal and parallel to $A_{5-8}B_8$, and $B_6'O'$ is equal and parallel to $A_{6-9}B_9$.

THE ELECTRIC TRANSMISSION OF POWER FROM NIAGARA FALLS—II.

BY LEWIS B. STILLWELL.

As regards the frequency chosen, *viz.*, 25 cycles per second, experience since 1893 has demonstrated the wisdom of its selection. This frequency is to-day more generally used in America in electrical distribution for power purposes than any other. Personally, I consider 30 cycles preferable, but at Niagara it was not possible to adopt this frequency for the reason that the speed of the turbines had been fixed at 250 revolutions per minute before the question of frequency was seriously considered. A 16-pole dynamo at 250 revolutions per minute will produce thirty-three and one-third cycles per second and a 12-pole dynamo 25 cycles per second. There were difficulties in the way of winding a 14-pole machine for two phases, and after very careful consideration of the relative advantages of 25 cycles and thirty-three and one-third cycles the former was chosen.

My principal reason for believing that a frequency of 30 cycles per second is preferable to 25 cycles per second is that 110-volt incandescent lamps of 16 candle-power or more, when supplied at that frequency from practically any commercial alternator, are free from any suspicion of fluctuation in candle-power due to reversal of current, while at 25 cycles such is not the case. At Niagara, the town of Echota is satisfactorily lighted by incandescent lamps using 25-cycle currents, but this result is somewhat assisted by the fact that the potential wave of the Niagara alternators is flatter than a sine curve. A great deal depends upon the form of the electro-motive-force wave, although I do not remember having seen this point mentioned in any of the published discussions of this subject. If the wave be pointed or peaked—*i. e.*, if the ratio of maximum to mean value of the electro-motive force during a half cycle materially exceeds the ratio of these quantities in a sine wave—incandescent lamps will show visible fluctuation at frequencies considerably higher than is the case if a flattened wave be used. Of course, a 110-volt lamp will show fluctuation under conditions when a 50-volt lamp will show none, and presumably 220-volt lamps are still more sensitive, although I have never tested this experimentally. I have found no reason, therefore, to modify the opinion first formed in 1890, that for plants in which the supply of power is the principal object, 30 cycles, which, with absolutely satisfactory results, permits also direct supply of incandescent lamps, is the best frequency.

The alternators were wound to deliver 3,730 kilowatts at any desired potential not less than 2,000 volts and not exceeding 2,400 volts. My intention in thus defining the limits of working potential was to provide for drop in transmitting and distributing circuits using 2,000 volts as the general potential delivered to users of the power and allowing in the generators for an increase of potential at terminals amounting to 20 per cent, which amount I considered might be necessary in undertaking very distant transmission at some future time. In some way which has never been clearly explained, the officers of the Cataract Construction Company apparently interpreted the phrase "from 2,000 to 2,400 volts" to mean 2,200 volts, and the apparatus used by the first electrical tenant of the power company, *viz.*, the Pittsburgh Reduction Company, which apparatus was supplied by the General Electric Company, was wound for 2,200 volts. In this way, the delivered potential at Niagara, and subsequently for reasons of uniformity in Buffalo, was fixed at 2,200 volts. The reasons for choosing a potential of about 2,000 volts are indicated by the following quotation from a letter which I wrote October 2, 1893:

We should mount the fields of the generators upon the extended turbine shafts and should wind the stationary armatures to deliver current at a potential of from 2,000 to 2,400 volts. This potential is well adapted to your work in Cataract City. It is sufficiently high to secure good economy in the system of distribution, and it is not so high as to impose special difficulty and danger in the insulation of the circuits and the manipulation of the switching devices. Motors may be operated from circuits conveying current at this potential without the use of step-down transformers.

For transmission to Buffalo and other distant points, we should advise a high potential, say 10,000 volts, obtained by step-up transformers. If possible, these transformers should be so designed and the units so selected as to permit an increase in potential of the long-distance transmission circuits, say to 20,000 volts, as soon as experience gained in transmission at 10,000 volts may indicate the practicability of insulating the circuits for the higher potential.

In our memoir of February 6, we recommended 800 volts for the potential in the distributing circuits in the vicinity of the city of Niagara Falls. We were largely guided then, as now, by the consideration that the potential selected should be the highest which may be safely employed at the motors without the interposition of step-down transformers. We assumed, however, at that time that there would be a very large proportion of small motors, as is the case in the hydraulic plant in Geneva, Switzerland, but we are now advised by your engineers that by far the larger part of the power called for in the vicinity of the Falls will be in units of not less than 25 horse-power. In such motors it will generally be safe to employ 2,000 volts.

As I have said, the alternating-current system rested, and still rests, upon the transformer, which, having no moving parts, yet enables us at will to transform from low potential to high potential and the reverse, utilizing extremely high and, therefore, economical potentials for transmitting power over long distances while employing moderate and easily handled potentials, both in the dynamos which produce the electricity and in the motors and lamps which utilize it in markets perhaps many miles distant.

The transformer of Gaulard, which was adapted to constant-current circuits, was brought to the United States by Westinghouse, and was there primarily developed by Stanley and Shallenberger, who early perceived the much greater usefulness of closely regulating transformers adapted to constant-potential circuits, and turned their efforts in that direction.

The polyphase motor, as invented by Tesla, occupied no such place in practical engineering work in 1893 as it does to-day, and the same is true of the rotary converter. Tesla and Scott in America, and Debrovolski in Berlin, had been gradually improving the motor until at the time named it was really a practical and successful machine under certain conditions, but it had not been widely introduced into commercial use, and the enthusiastic hopes aroused when the Tesla invention was first announced, in 1888, had not been realized by the public nor were its possibilities and limitations realized even by electrical engineers, except those who were actually in touch with the work of experimental development.

That the Cataract Construction Company displayed courage as well as good judgment in adopting alternating currents in 1893, and that the subject of alternating-current motors was little understood by engineers outside of certain factories at that time is well illustrated by the fact that one of the consulting engineers of the Cataract Construction Company, in a paper on "The Electric Transmission of Power from Niagara," read before the British Institution of Electrical Engineers, November 9, 1893, attaches great weight to the alleged possibility of converting continuous-current motors into synchronous alternating-current motors by the addition of rings. On page 503 of the *Journal* of that society, he says:

In concluding my remarks upon low frequency I must again repeat that, from a purely practical and commercial point of view, one of the great advantages lies in the fact that for any special purpose for which a motor is required any ordinary direct-current motor may be altered so as to act as a synchronizing alternating motor at a very small expenditure of time and money.

The author apparently had in mind the use of an extremely low frequency, but the fact that he seriously believed in the possibility of converting into commercially effective alternating-current motors the general run of continuous-current motors is enough to indicate the vague ideas then generally prevalent with regard to alternating-current motors.

As regards rotary converters, the function of which is the conversion of alternating currents to continuous currents, thus rendering available for electrolytic work and for operation of continuous-current motors power transmitted in the form of alternating currents, even less was generally known. Schuckert exhibited small machines of this character at the Frankfort exposition in 1890, and in America, Bradley and others had been engaged with more or less success in developing commutating machines of various types. During the autumn of 1892 the Westinghouse company invited the Cataract Construction Company to examine two 150-horse-power rotary converters, and on January 19, 1893, Dr. Coleman Sellers and the late Professor Henry A. Rowland carefully tested these machines in Pittsburgh. The machines were simply two four-pole, continuous-current, 500-volt generators fitted with ring collectors. Continuous current at 500 volts was delivered to the first machine, which, operating as a rotary converter, delivered alternating current at 25 cycles per second to a second machine, which, in turn, operating as a rotary converter, delivered a continuous current through a resistance. The energy supplied to the first machine and the energy delivered by the second machine were measured and compared, the difference representing the sum of the losses in the two machines. The approximate efficiency of each machine was calculated by dividing the output of the second machine by input of first machine and extracting the square root of the quotient. The efficiency thus obtained for various outputs of the second machine was as follows:

Output of Second Converter.	Approximate Efficiency of Each Converter.
20,560 watts.	78.9 per cent.
57,270 watts.	90.0 per cent.
117,970 watts.	91.5 per cent.

These results will compare favorably with those that are now obtained in machines of similar output.

In the autumn of 1892, as electrical engineer of the Westinghouse company, and in cooperation with Albert Schmid, O. F. Shallenberger, Charles F. Scott and B. F. Lamme, I planned an organization of electrical apparatus to be exhibited at the World's Fair, in Chicago, the following year for the purpose of illustrating the possibilities of electric power transmission. The apparatus was constructed and was shown in operation in Chicago from May to November, 1893. The Fig. 1, which is photographically reproduced from a descriptive publication which I prepared at that time, shows that this exhibit comprised every essential feature which is today utilized by the plant of the Niagara Falls Power Company, except the two-phase three-phase connection of the transformers. In the diagram, A and B are alternators; D, the power-house switchboard; RT, RT′, etc., raising transformers; L, L′, etc., transmission circuits; LT, LT,′ etc., step-down transformers; F, the distributing switchboard in a substation; MG, the motor-generator or rotary converter, receiving alternating current and delivering continuous current for the operation of a street railway; MG′, and MG², rotary converters delivering continuous current, respectively, to electrolytic plants and to direct-current arc lamps; MM′, etc., polyphase alternating-current motors, and *b b′*, etc., step-down transformers supplying incandescent lamps. In the plant exhibited at Chicago, one 375-kilowatt, two-phase alternator; one 375-kilowatt rotary converter, delivering continuous current at 550 volts; one 60-horse-power synchronous motor and a number of smaller machines, including induction motors up to about 15 horse-power were shown.

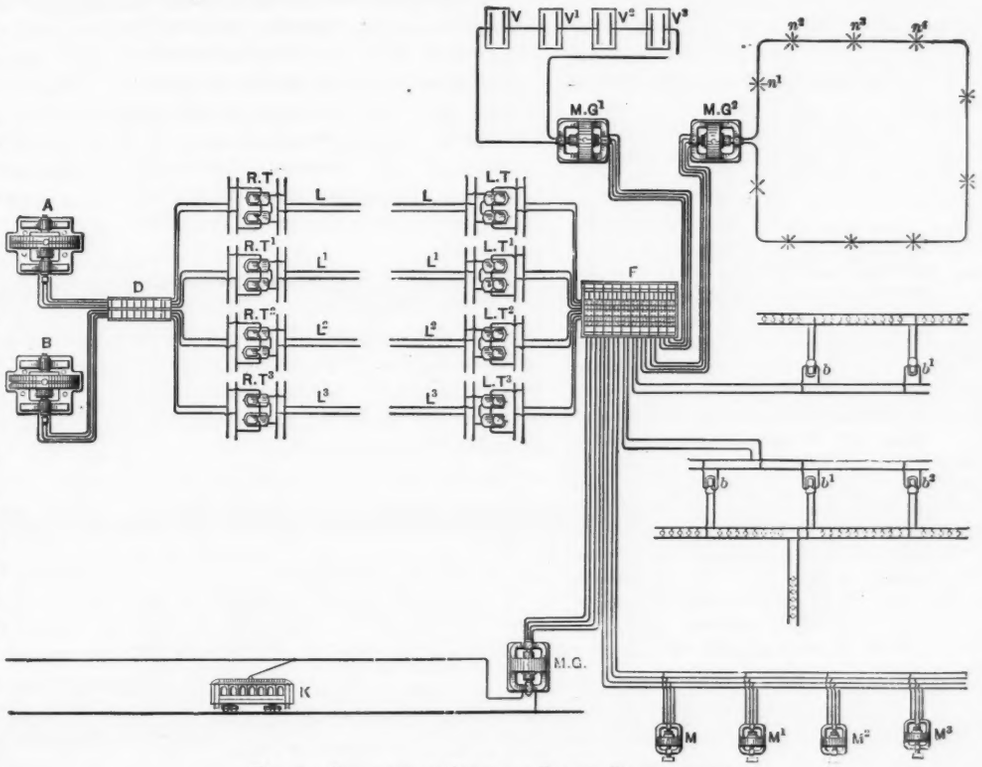


FIG. 1.—DIAGRAM OF ELECTRIC POWER TRANSMISSION.

The frequency was 30 cycles per second, the transmission potential 10,000 volts. A 60-horse-power direct-current motor, using current from the rotary converter, was used to drive an Ingersoll-Sargent air compressor. The 60-horse-power synchronous motor was shown in operation. Incandescent lamps were supplied through transformers and arc lamps by continuous current obtained from a rotary converter.

I deem it proper to make this record in this place not only as a matter of justice to my associates and myself, who did much work from 1888 to 1898 in evolving the system adopted at Niagara, but also to establish a fact which is of interest to the Institute; *viz.*, that while the Niagara plant embodies the ideas of many men—

British and Continental, as well as American—the evolution and development of each of the important parts of the system as used at Niagara and the aggregation of these parts into a working plant, accurately adjusted, easily controlled and delivering power to-day for a multiplicity of purposes in western New York was American, as the far-sighted business enterprise which invested very large capital in a project depending for success upon many factors not tested by experience was also American.

In the descriptive memoir of February, 1893, from which I have above quoted, the application of the system proposed to a territory already occupied by competing steam-driven plants was pointed out as follows:

Your two-phase alternating current, delivered at high potential at the northern boundary of the city, must be reduced by transformers to a potential that may be safely carried on local distributing circuits. Your company, or the company to which you will sell current delivered in Buffalo, will desire to make a proposal to the city looking to the substitution of motors for the pumping engines now in use for this purpose. The system offers the two-phase synchronous motors of large capacity—probably of capacity corresponding with that of the engines now installed. These machines will be self-starting, and, using ring collectors in place of commutators, their construction is such as will make maintenance a minimum.

You will also desire to supply power for the operation of the street railway systems of the city. Our system makes it possible to approach the street railway companies with alternative propositions; first, to furnish motors to drive generators in place of the engines now in use; second, to substitute revolving transformers for both engines and generators; that is to say, to put in place of one engine and one generator a single machine operating at an efficiency of from 92 per cent to 95 per cent, depending upon its capacity. The entire steam and electric plant now installed can be held in reserve or sold.

As regards the arc lighting of the city, you can also make alternative propositions; first, to substitute synchronous motors for engines now in use; second, to install rotary transformers, making a total change in the arc lighting system. In all probability the first of these will be the practicable method at the present time; but the direct and economical method of using the energy of your water power to supply arc lights in Buffalo will ultimately involve a total change of system, and the abandonment of the arc lighting apparatus now used.

For incandescent lighting, the system also offers alternative methods; first, the substitution of synchronous motors for engines; second, a change of system, and the use of large transformers reducing potential from local primary distributing circuits to 50 or 100 volts in secondary circuits. While it may be necessary for a time, owing to the fact that several different interests are concerned, to use the electric energy transmitted from the Falls to supply motors driving existing electric generating apparatus, the system which we have laid out looks to the future, and will lend itself at any time when commercial considerations may permit, to a broad-gauge solution of the problem of utilizing the energy of Niagara Falls to supply power and light to the city of Buffalo in the most direct, efficient and satisfactory manner.

The high-potential current now actually delivered to transformers in the terminal house near the northern boundary of Buffalo is three-phase and not two-phase as anticipated in the memoir referred to. The change, which, of course, implied a very marked reduction in cost of transmitting and distributing circuits, was made possible a few months later by the invention of the two-phase three-phase connection of step-up transformers, without departing from the use of two-phase alternators.

A considerable number of synchronous motors are to-day in use in Buffalo, but they are three-phase and not two-phase induction motors. The street railway systems of the city are operated by power supplied through converting machinery as described in the memoir.

The arc lighting of the city is accomplished at present by the first of the two alternative methods outlined in the memoir—*viz.*, the use of synchronous motors in place of engines.

Incandescent lighting in Buffalo is supplied with power in large part by synchronous motors driving constant potential, 60-cycle, two-phase alternators, and, to a less extent, by direct current obtained from rotary converters.

Wood Dried by Electricity.

The following description of a new method of quickly drying wood for building and manufacturing purposes is described by United States Consul Mahin, of Reichenberg, Austria: The green wood is placed in a large wooden trough, whose bottom is covered with a lead plate, which is connected with the positive pole of an electric battery. Covering the wood is a second lead plate, which forms the negative pole. The wood is then subjected to a bath in a solution composed of 10 per cent rosin and 75 per cent soda. Under the influence of the electric current the sap is drawn out of the wood and rises to the surface, the solution being absorbed by the wood. The operation requires from five to eight hours. The wood is then allowed to dry for about two weeks, when it is ready for use; or the drying can be done artificially in a much shorter time.

A Royal Trolley Car.

The first electric car to be provided for the exclusive use of European royalty in America has been furnished by the Ottawa, Quebec, Electric Railway Company for the use of the Duke and Duchess of Cornwall and York. This trolley car, named "The Duchess of Cornwall and York," after her royal highness, recently made a trial run through the city of Ottawa and out to Britannia on the Bay, and on this experimental trip its performance was entirely satisfactory.

The brake and the motor equipment are entirely of Westinghouse manufacture. Four railway motors, of 50 horse-power each, drive the car at a speed of 50 miles per hour, and at this high speed the motion is entirely controlled by automatic air brakes.

The car is 50 feet in length, straight sides and vestibuled at both ends, with full monitor roof of the Pullman pattern. The color of the car is also Pullman standard, with the British coat of arms conspicuously displayed on its front and rear. The interior is finished in antique polished oak, with a handsomely decorated ceiling of three-ply bird's-eye maple veneer. At either end of the car, and set in frames, are two large British plate mirrors that greatly enhance the beauty of the interior decoration. Rich bronze trimmings—the hat-racks, hooks, etc., are of solid bronze—heighten the luxuriousness of this royal car, which, at night, is resplendent with the illumination of five beautifully clustered groups of incandescent lamps. A rich, royal blue velvet carpet covers the floor, and from the windows hang highly ornamental curtains of the latest pattern. For the comfort of the occupants, large easy chairs, beautifully upholstered in olive green plush, are provided.

Their graces, the Duke and Duchess of Cornwall and York, are not, however, the first royal personages to possess an exclusive electric car. This distinction belongs to an Oriental sovereign, the Emperor of Korea, who but recently had a trolley car built for his private use, all of which is, perhaps, a rather curious commentary on European progressiveness and Oriental conservatism. This car likewise was equipped by the Westinghouse company.

At the University of Königsberg, Germany, the professors of anatomy, chemistry and physics have excluded women students from their lectures, with the result that women can not study medicine regularly at that institution.

SYNCHRONISM AND FREQUENCY INDICATION—III.

(Concluded.)

BY PAUL M. LINCOLN.

Methods of obtaining supersensitive or hypersensitive points of mechanical angle change with respect to phase angle changes are given in the first part of this paper. These methods are as applicable to this frequency meter as the synchronism indicator. For instance, suppose it is desired to carry sensitiveness at the point of resonance to a point beyond the possible limits of

$$\frac{2\,L}{R}$$

This can evidently be accomplished by diminishing that armature current whose phase nearest coincides with that of the field current. By this means sensitiveness may be carried to any limit desired.

step further and omit entirely that armature element which is in phase with the impressed electro-motive force. Then by adjusting the inductance and capacity in the field circuit so that there is no torque exerted on that armature element whose current differs by 90 degrees from the electro-motive force impressed on the field, the frequency of the impressed electro-motive force is measured directly by

$$\sqrt{\frac{1}{CL}} \times \frac{1}{2\,\pi}$$

In applying this device to the frequency measurements of a power or lighting circuit, the most natural method of obtaining the phase difference required by the two armature elements is to connect a non-inductive resistance in series with one of them and an inductive resistance in series with the other. Although it is impossible by this method to reach a phase difference of 90 degrees, it can be nearly enough approximated to answer every purpose. There is one advantage which pertains to this method of obtaining the phase difference between the armature elements. The current in the inductive element is inversely proportional to frequency, and since sensitiveness at the point of resonance is directly proportional to this ratio, the expression (23) becomes

$$\frac{d\,\theta}{d\,\omega} = -\frac{2\,L}{R}\,\frac{\omega_1}{\omega} \qquad (26)$$

and the instrument's indication in degrees for a one-per-cent change of frequency becomes

$$\frac{7.2\,L\,n_1}{R} \qquad (27)$$

n_1 and ω_1 are here the frequency and angular velocity at which the currents in the two armature elements are equal. Advantage lies in the fact that the expression (27) is independent of frequency.

The device is evidently applicable to the measurement of the speed of any rotating body by attaching thereto a small alternating-current dynamo. By making the dynamo two-phase, the proper phase relation for armature elements of the meter can be easily obtained. One advantage of using this style of meter is that its indications are dependent only on the frequency of impulses transmitted thereto, and are independent of the voltage applied, so long as it is sufficient to operate the instrument.

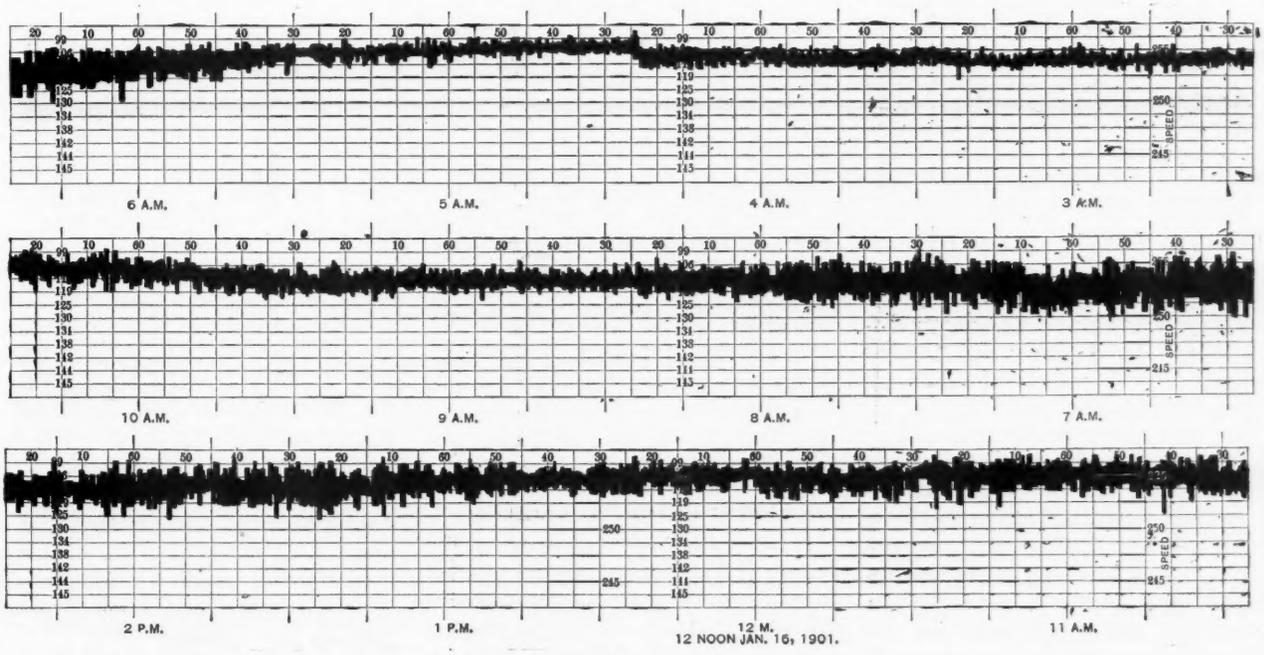


FIG. 4.—SPEED RECORD.

By certain modifications, an instrument may be made to possess the double advantage of long range and extreme sensitiveness. Adjust an instrument to extreme sensitiveness at resonance by properly fixing the ratio of the two armature elements. Now by placing in series with the field an adjustable capacity or an adjustable inductance, or both, the normal frequency to be measured may be brought within the comparatively narrow range of the instrument, and the frequency to which the instrument is adjusted may be found by noting the values of inductance and capacity in circuit. Or we can go a

It may be interesting to enumerate the most apparent advantages of frequency or speed indicator such as has been described.

1. First its point of greatest sensitiveness comes at the point of normal speed or frequency at which point it is, as a rule, most desired.

2. The point of normal frequency may be made adjustable by including in circuit an adjustable capacity or inductance.

3. The point of normal frequency may be predetermined by electrical measurements.

4. It may be made general in its application as a speed indicator by the addi-

tion of a small alternating-current dynamo.

5. It may be placed any desired distance from the body whose speed of rotation it is desired to measure.

The condition which originally led to the design of the apparatus was the complaint made to the Niagara Falls Power Company by its distributing agent in Buffalo, the Cataract Power and Conduit Company, that there occurred at times an undue fluctuation of speed.

The tachometers at that time used by the Niagara Falls Power Company were not sufficiently sensitive to indicate the fluctuation complained of. A recording tachometer was obtained and put into service. This recording instrument depended on centrifugal force for its action, but its sensitiveness was far too small to measure the fluctuations we wished to record. A conception of the instrument described above occurred to the writer. An instrument was made up, a pen was attached to its armature, and it was set to recording the frequency fluctuations on the Buffalo circuit where it has been doing successful duty ever since. So far as the writer is aware it is the first instrument of its kind ever made, and its success has induced the writer to give a description of it to the Institute.

A few sample speed records as made by this instrument may be of interest. Fig. 4 shows a speed record made on January 16, 1901. At first glance the speed fluctuations seem to be severe, but when it is remembered that each horizontal line represents a speed change of one-half per cent and that the speed curve is that of a water-driven dynamo operating on a load largely composed of street railway service, engineers familiar with the difficulties will undoubtedly agree that the results obtained are above the average.

The very considerable improvement exhibited between the chart of January 16, 1901, and that of March 3, 1901 (Fig. 5), is in a large measure due to the existence of a continuous speed record giving an opportunity to note the most efficient governor adjustments.

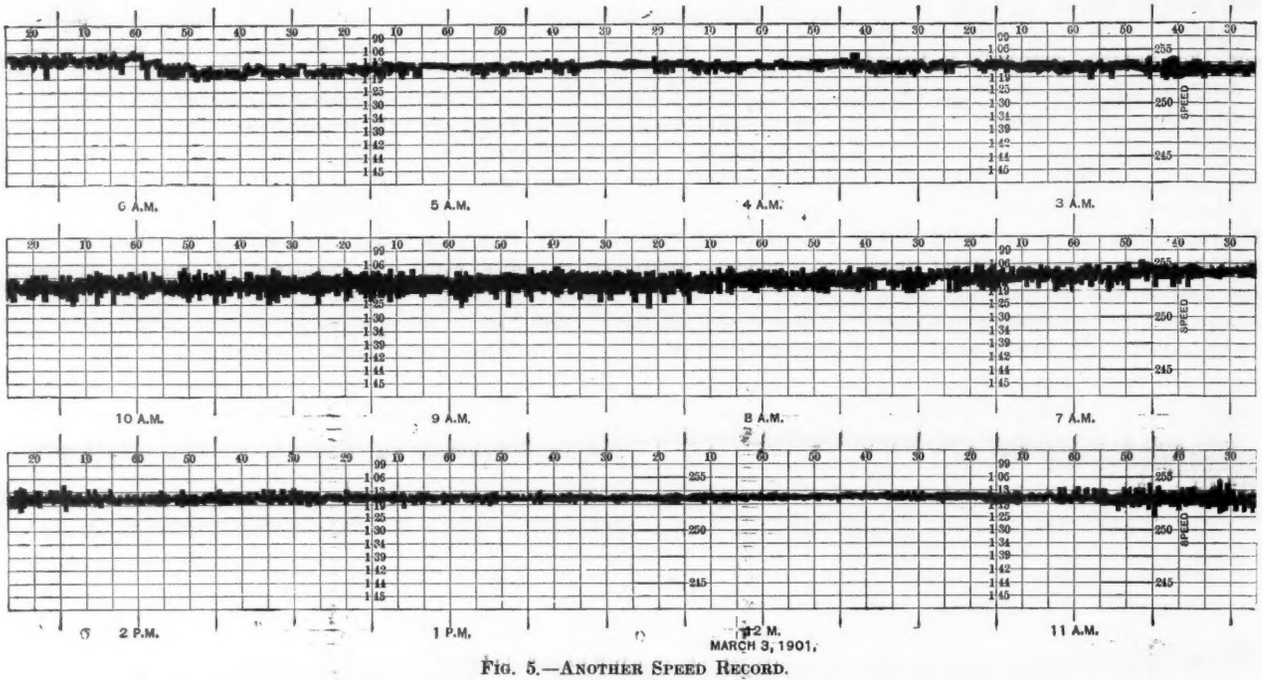


FIG. 5.—ANOTHER SPEED RECORD.

Electric Railway at Carlsbad.

It is reported by United States Consul Mahin, of Reichenberg, Austria, that an electric street railway company has been formed at Carlsbad, and that negotiations with supply and construction firms are invited. Carlsbad is as yet devoid of any kind of public conveyance, except cabs and hotel omnibuses, though it has a permanent population of 15,000, to which are added between April and October of every year 40,000 or more sojourners. The city is spread out, along the Tepl River, a distance of several miles, from the railway station to the Posthof, between which points street-car communication would prove a great boon to the permanent and sojourning population. Branch lines on side streets leading to the villas and hotels on the adjacent heights would also be practicable. Communications addressed to the Elektrische Strassenbahngesellschaft, Carlsbad, Bohemia, would reach those interested in this project.

Trial of Motor Vehicles.

The third trial of motor vehicles for heavy traffic, conducted by the Liverpool Self-Propelled Traffic Association, has resulted in the award of gold medals to the following vehicles in each of the four classes:

Class A: Load, 1½ tons; maximum tare, 2 tons; minimum level platform area, 45 square feet; minimum width of driving tires, 3 inches; speed, 8 miles per hour. Geo. F. Milnes & Company, Limited, motor department, "Motoria," 17 Balderton street, Oxford street, London.

Class B: Load, 5 tons; maximum tare, 3 tons; minimum level platform area, 75 square feet; minimum width of driving tires, 5 inches; speed, 5 miles per hour. The Lancashire Steam Motor Company, Leyland, near Preston.

Class C: Minimum load, 5 tons; no tare limit; minimum level platform area, 95 square feet; minimum width of driving tires, 6 inches; speed, 5 miles per hour. The Thornycroft Steam Wagon Company, Limited, Chiswick and Basingstoke.

Class D: Minimum load, 4 tons; no tare limit; level platform area not specified; minimum width of driving tires, 4 inches; speed, 5 miles per hour. The Thornycroft Steam Wagon Company, Limited, and T. Coulthard & Company, Limited, Cooper road, Preston.

The silver medal of the association was awarded to the Mann Patent Steam Cart and Wagon Company, Limited, Canning Works, Dewsbury road, Leeds.

THEORETICAL INVESTIGATION OF SOME OSCILLATIONS OF EXTREMELY HIGH POTENTIAL IN ALTERNATING HIGH POTENTIAL TRANSMISSIONS—II.

BY CHARLES P. STEINMETZ.

At times: $t = 0$, or: $\varphi = 0$, it is substituting in (14) and (15)

$$\left.\begin{aligned} i_0 &= C_1 + \frac{E}{z_0}\cos(\omega + a) \\ e_0 &= -\frac{r}{2}C_1 + \frac{q}{2}C_2 - \frac{k}{z_0}E\sin(\omega + a) \end{aligned}\right\}$$

and herefrom:

$$\left.\begin{aligned} C_1 &= i_0 - \frac{E}{z_0}\cos(\omega + a) \\ C_2 &= \frac{2e_0 + r i_0}{q} + \frac{E}{q z_0}[2k\sin(\omega + a) - r\cos(\omega + a)] \end{aligned}\right\} \quad (16)$$

Substituting (16) in (14) and (15), gives:

Current:

$$\left.\begin{aligned} i = \frac{E}{z_0}\cos(\varphi - \omega + a) + \varepsilon^{-\frac{r}{2x}}\Big\{\Big[i_0 - \frac{E}{z_0}\cos(\omega + a)\Big]\cos\frac{q}{2x}\varphi \\ -\Big[\frac{2e_0 + r i_0}{q} + \frac{E}{q z_0}\Big(2k\sin(\omega + a) - r\cos(\omega + a)\Big)\Big]\sin\frac{q}{2x}\varphi\Big\} \end{aligned}\right\} \quad (17)$$

Potential difference at condenser:

$$\begin{aligned} e_1 = \frac{k}{z_0}E\sin(\varphi - \omega + a) + \varepsilon^{-\frac{r}{2x}\varphi}\Big\{\Big[e_0 + \frac{k}{z_0}E\sin(\omega - a)\Big]\cos\frac{q}{2x}\varphi \\ + \Big[\frac{2re_0 + (r^2 + q^2)i_0}{2q} + \frac{E}{2qz_0}(2kr\sin(\omega - a) \\ - (r^2 + q^2)\cos(\omega - a)\Big]\sin\frac{q}{2x}\varphi\Big\} \end{aligned}$$

These equations (17) can be essentially simplified by neglecting terms of secondary magnitude.

k is in high-potential transmission lines or cables always very large compared with r and x.

The full load resistance and reactance voltage may vary from less than five per cent to about 20 per cent of impressed voltage, the charging current of the line from five per cent to about 20 per cent of full load current, at normal voltage and frequency.

In this case, k is from 25 to more than 400 times as large as r or x, and r and x thus negligible compared with k.

It is, then, in close approximation:

$$\left.\begin{aligned} z_0 &= k \\ q &= 2\sqrt{xk} \\ B &= \frac{E}{k} \\ a &= \frac{\pi}{2} = q\,0^0 \end{aligned}\right\} \quad (18)$$

Substituting these values in equations (17), gives:

Current:

$$i = -\frac{E}{k}\sin(\varphi - a) + \varepsilon^{-\frac{r}{2x}\varphi}\Big\{\Big[i_0 - \frac{E}{k}\sin a\Big]\cos\sqrt{\frac{k}{x}}\varphi - \Big[\frac{2e_0 + r i_0}{2\sqrt{xk}} - \frac{E}{2\sqrt{xk}}(2\cos\omega + \frac{r}{k}\sin\omega)\Big]\sin\sqrt{\frac{k}{x}}\varphi \quad (19)$$

Potential difference at condenser:

$$e_1 = E\cos(\varphi - \omega) + \varepsilon^{-\frac{r}{2x}\varphi}\Big\{[e_0 - E\cos\omega]\cos\sqrt{\frac{k}{x}}\varphi + \Big[\frac{2re_0 + (r^2 + 4xk)i_0}{4\sqrt{xk}} - \frac{E}{4\sqrt{xk}}(2r\cos\omega + \frac{r^2 + 4xk}{k}\sin\varepsilon)\Big]\sin\sqrt{\frac{k}{x}}\varphi\Big\}$$

These equations consist of three terms:

$$\left.\begin{aligned} i &= i' + i'' + i''' \\ e_1 &= e_1' + e_1'' + e_1''' \end{aligned}\right\} \quad (20)$$

$$\left.\begin{aligned} i' &= -\frac{E}{k}\sin(\varphi - \omega) \\ e_1' &= E\cos(\varphi - \omega) \end{aligned}\right\} \quad (21)$$

$$\left.\begin{aligned} i'' &= -\frac{E}{k}\varepsilon^{-\frac{r}{2x}\varphi}\Big\{\sin\omega\cos\sqrt{\frac{k}{x}}\varphi - \Big[\sqrt{\frac{k}{x}}\cos\omega + \frac{r}{2\sqrt{xk}}\sin\omega\Big]\sin\sqrt{\frac{k}{x}}\varphi\Big\} \\ e_1'' &= -E\,\varepsilon^{-\frac{r}{2x}\varphi}\Big\{\cos\omega\cos\sqrt{\frac{k}{x}}\varphi + \Big[\frac{r}{2\sqrt{xk}}\cos\omega + \frac{r^2 + 4xk}{4k\sqrt{xk}}\sin\omega\Big]\sin\sqrt{\frac{k}{x}}\varphi\Big\} \end{aligned}\right\} \quad (22)$$

or, by dropping terms of secondary order:

$$\left.\begin{aligned} i'' &= \frac{E}{\sqrt{x\,k'}}\,\varepsilon^{-\frac{r}{2x}\varphi}\cos\omega\sin\sqrt{\frac{k}{x}}\,\varphi \\ e_1'' &= -E\,\varepsilon^{-\frac{r}{2x}\varphi}\cos\omega\cos\sqrt{\frac{k}{x}}\,\varphi \end{aligned}\right\} \quad (23)$$

$$\left.\begin{aligned} i''' &= \varepsilon^{-\frac{r}{2x}\varphi}\left\{ i_0\cos\sqrt{\frac{k}{x}}\,\varphi - \frac{2e_0 + r\,i_0}{2\sqrt{x\,k}}\sin\sqrt{\frac{k}{x}}\,\varphi \right\} \\ e_1''' &= \varepsilon^{-\frac{r}{2x}\varphi}\left\{ e_0\cos\sqrt{\frac{k}{x}}\,\varphi + \frac{2\,r\,e_0 + (r^2+4\,x\,k)\,i_0}{4\sqrt{x\,k}}\sin\sqrt{\frac{k}{x}}\,\varphi \right\} \end{aligned}\right\} \quad (24)$$

or, by dropping terms of secondary order:

$$\left.\begin{aligned} i''' &= \varepsilon^{-\frac{r}{2x}\varphi}\left\{ i_0\cos\sqrt{\frac{k}{x}}\,\varphi - \frac{e_0}{\sqrt{x\,k}}\sin\sqrt{\frac{k}{x}}\,\varphi \right\} \\ e_1''' &= \varepsilon^{-\frac{r}{2x}\varphi}\left\{ e_0\cos\sqrt{\frac{k}{x}}\,\varphi + i_0\sqrt{x\,k}\sin\sqrt{\frac{k}{x}} \right\} \end{aligned}\right\} \quad (25)$$

Thus

Total current, approx:

$$i = -\frac{E}{k}\sin(\varphi-\omega) + \varepsilon^{-\frac{r}{2x}\varphi}\left\{ i_0\cos\sqrt{\frac{k}{x}}\,\varphi - \frac{e_0 - E\cos\omega}{\sqrt{x\,k}}\sin\sqrt{\frac{k}{x}}\,\varphi \right\}$$

Difference of potential at condenser:

$$e_1 = E\cos(\varphi-\omega) + \varepsilon^{-\frac{r}{2x}\varphi}\left\{ (e_0 - E\cos\omega)\cos\sqrt{\frac{k}{x}}\,\varphi + i_0\sqrt{x\,k}\sin\sqrt{\frac{k}{x}}\,\varphi \right\} \quad (26)$$

Of the three terms: i', e_1'; i'', e_1''; i''', e_1''', the first obviously represents the stationary condition of charging current and condenser potential, since the two other terms disappear for $t = \infty$.

The second term, i'', e_1'', represents that component of oscillation which depends upon the phase of impressed electro-motive force or the point of the impressed electro-motive-force wave, at which the oscillation begins, while the third term, i''', e_1''', represents the component of oscillation which depends upon the instantaneous values of current resp. electro-motive force at the moment at which the oscillation begins. $\varepsilon - (r/2x)\,\varphi$ is the decrement of the oscillation.

The frequency of oscillation is:

$$N_0 = \sqrt{\frac{k}{x}}\,N$$

where N is the impressed frequency. That is, the frequency of oscillation equals the impressed frequency times the square root of the ratio of capacity reactance and inductive reactance of the circuit, or is the impressed frequency divided by the square root of inductance voltage and capacity current, as fraction of impressed voltage and full load current.

Since:

$$k = \frac{1}{2\pi N C},\quad x = 2\pi N L,$$

the frequency of oscillation is:

$$N_0 = \frac{1}{2\pi\sqrt{C L}}$$

that is, independent of the frequency of the impressed electro-motive force.

Substituting:

$$\varphi = 2\pi N t,\quad k = \frac{1}{2\pi N C},\quad x = 2\pi N L$$

in equations (23), (25) and (26), it is:

$$\left.\begin{aligned} i'' &= \sqrt{\frac{C}{L}}\,E\,\varepsilon^{-(r/2L)\,t}\cos\omega\sin\frac{t}{\sqrt{C L}} \\ e_1'' &= -E\,\varepsilon^{-(r/2L)\,t}\cos\omega\cos\frac{t}{\sqrt{C L}} \end{aligned}\right\} \quad (27)$$

$$\left.\begin{aligned} i''' &= \varepsilon^{-(r/2L)\,t}\left\{ i_0\cos\frac{t}{\sqrt{C L}} - e_0\sqrt{\frac{C}{L}}\sin\frac{t}{\sqrt{C L}} \right\} \\ e_1''' &= \varepsilon^{-(r/2L)\,t}\left\{ e_0\cos\frac{t}{\sqrt{C L}} + i_0\sqrt{\frac{L}{C}}\sin\frac{t}{\sqrt{C L}} \right\} \end{aligned}\right\} \quad (28)$$

$$\left.\begin{aligned} i &= -2\pi N C E\sin(\varphi-\omega) + \varepsilon^{-(r/2L)\,t}\left\{ i_0\cos\frac{t}{\sqrt{C L}} - (e_0 - E\cos\omega)\sqrt{\frac{C}{L}}\sin\frac{t}{\sqrt{C L}} \right\} \\ e_1 &= E\cos(\varphi-\omega) + \varepsilon^{-(r/2L)\,t}\left\{ (e_0 - E\cos\omega)\cos\frac{t}{\sqrt{C L}} + i_0\sqrt{\frac{L}{C}}\sin\frac{t}{\sqrt{C L}} \right\} \end{aligned}\right\} \quad (29)$$

The oscillating terms of these equations are independent of the impressed frequency. That is, the oscillating current and potential difference, caused by a change of circuit conditions (as starting, change of load or opening circuit), are independent of the impressed frequency, and thus also of the wave shape of the impressed electro-motive force, or its higher harmonics (except as regards to terms of secondary order).

The first component of oscillation, equations (22) and (23), besides upon the line constants and upon the impressed electro-motive force depends only upon the phase, or the point of the impressed electro-motive-force wave, at which the oscillation starts, but does not depend upon the previous condition of the circuit.

Therefore this component of oscillation is the same as the oscillation produced in starting the transmission line, that is, connecting it, unexcited, to the generator terminals.

There exists no point of the impressed electro-motive-force wave, where no oscillation occurs (while, when starting a circuit containing resistance and induction only, at the point of the impressed electro-motive-force wave, where the final current passes zero, the stationary condition is instantly reached).

With capacity in circuit, any change of circuit conditions involves an electric oscillation.

The maximum intensity of starting oscillation occurs near the value: $a = o$, and is:

$$\left.\begin{aligned} i'' &= \frac{E}{\sqrt{x\,k}}\,\varepsilon^{-(r/2x)\,\phi}\sin\sqrt{\frac{k}{x}}\,\varphi \\ e_1'' &= -E\,\varepsilon^{-(r/2x)\,\phi}\cos\sqrt{\frac{k}{x}}\,\varphi \end{aligned}\right\} \quad (30)$$

Since:

$$i' = -\frac{E}{k}\sin(\varphi - \omega)$$

is the stationary value of charging current, it follows:

The maximum intensity which the oscillating current produced in starting a transmission line may reach, is $\sqrt{\frac{k}{x}}$ times the stationary charging current, or the initial rush of current bears to the stationary value the same ratio as the frequency of oscillation to the impressed frequency.

The maximum oscillating electro-motive force induced in starting a transmission line is of the same value as the impressed electro-motive force. Thus the maximum value of potential difference occurring in a transmission line at starting is less than twice the impressed electro-motive force and no excessive voltages can be induced in starting a circuit.

The minimum value of starting oscillation occurs near: $\omega = 90°$, and is, from equations (22):

$$\left.\begin{aligned} i'' &= -\frac{E}{k}\,\varepsilon^{-(r/2x)\,\phi}\cos\sqrt{\frac{k}{x}}\,\varphi \\ e_1'' &= \sqrt{\frac{x}{k}}\,E\,\varepsilon^{-(r/2x)\,\phi}\sin\sqrt{\frac{k}{x}}\,\varphi \end{aligned}\right\} \quad (31)$$

That is, the oscillating current is of the same intensity as the charging current, and the maximum rush of current thus is less than twice the stationary value. The potential difference in the circuit rises only little above the impressed electro-motive force.

The second component of oscillation, equations (24) (25), does not depend upon the point of the impressed electro-motive force wave, at which the oscillation starts, ω, nor upon the impressed electro-motive-force as a whole, E, but, besides upon the constants of the circuit, it only depends upon the instantaneous values of current and of potential difference in the circuit at the moment where the oscillation starts, i_o and e_o.

Thus, if: $i_o = 0$, $e_o = 0$, or in starting a transmission line, unexcited, by connecting it to the impressed electro-motive force, this term disappears.

It is this component which may cause excessive potential differences.

Two cases shall more fully be discussed.

(*a*) Opening the circuit of a transmission line under load.

(*b*) Rupturing a short-circuit on the transmission line.

A.

If i_o is the instantaneous value of full load current, e_o the instantaneous value of difference of potential at the condenser, it is:

ri_o small compared with e_o:

$\sqrt{x\,k}\,i_0$ of the same magnitude as e_0.

Denoting:

$$\tan\delta = \frac{e_0}{i_0\sqrt{x\,k}}$$

it is, substituting in equations (24):

$$\left.\begin{aligned} i''' &= \sqrt{i_0^2 + \frac{e_0^2}{x\,k}}\,\varepsilon^{-(r/2x)\,\phi}\cos\left(\sqrt{\frac{k}{x}}\,\varphi + \delta\right) \\ e_1''' &= \sqrt{e_0^2 + i_0^2\,x\,k}\,\varepsilon^{-(r/2x)\,\phi}\sin\left(\sqrt{\frac{k}{x}}\,\varphi + \delta\right) \end{aligned}\right\} \quad (32)$$

That is, the amplitude of oscillation is:

$$\sqrt{i_0^2 + \frac{e_0^2}{x\,k}}$$

for the current, $\sqrt{e_0^2 + i_0^2\,x\,k}$ for the electro-motive force. Thus the induced electro-motive force can be larger than the impressed electro-motive force, but is, as a rule, still of the same magnitude, except if k is very large.

In the expression of the total current resp. potential difference at condenser, in equations (26), $(e_o - E\cos\omega)$ is the difference between the potential difference at the condenser and the impressed electro-motive force, at the instant of starting of the oscillation, or the voltage consumed by the line impedance, and this is small, if the current is not excessive. Thus, neglecting the terms with $(e_o - E\cos\omega)$, equations (26) assume the form:

$$\left.\begin{aligned} i &= -\frac{E}{k}\sin(\varphi - \omega) + i_0\,\varepsilon^{-(r/2x)\,\phi}\cos\sqrt{\frac{k}{x}}\,\varphi \\ e_1 &= E\cos(\varphi - \omega) + i_0\sqrt{x\,k}\,\varepsilon^{-(r/2x)\,\phi}\sin\sqrt{\frac{k}{x}}\,\varphi \end{aligned}\right\} \quad (33)$$

That is, the oscillation of current is of the amplitude of full load current, and the oscillation of condenser potential is of the amplitude $i_o\sqrt{x\,k}$.

$x\,k$ is the ratio of inductance voltage to condenser current, in fractions of full load voltage and current. It is also:

$$i_0\sqrt{x\,k} = i_0\sqrt{\frac{L}{C}}$$

Thus, in circuits of very high inductance L and relative low capacity C, $i_o\sqrt{x\,k}$ may be much higher than the impressed electro-motive force, and a serious rise of potential occur in opening the circuit under load, while in low-inductance cables of high capacity, $i_o\sqrt{x\,k}$ is moderate. That is, the inductance, by tending to maintain the current, induces a rise of potential, while capacity exerts a cushioning effect. Low inductance and high capacity thus are of advantage when breaking full load current in a circuit.

B.

If a transmission line containing resistance, inductance and capacity is short-circuited, and the short-circuit suddenly opened at time $t = 0$, it is, for: $t < 0$:

$$\left.\begin{aligned} e_0 &= 0 \\ i &= \frac{E}{z}\cos(\varphi-\omega-j) \\ \text{where:}\quad z &= \sqrt{r_2+x_2} \\ \tan j &= \frac{x}{r} \end{aligned}\right\} \quad (34)$$

thus, at time: $t = 0$

$$i_0 = \frac{E}{z}\cos(\omega+j) \quad (35)$$

Substituting these values of e_0 and i_0 in equations (24), gives:

$$i''' = \frac{E}{z}\cos(\omega+j)\,\varepsilon^{-(r/2x)\phi}\left\{\cos\sqrt{\frac{k}{x}}\varphi - \frac{r}{2\sqrt{xk}}\sin\sqrt{\frac{k}{x}}\varphi\right\}$$

$$e_1''' = \frac{E}{z}\cos(\omega+j)\,\varepsilon^{-(r/2x)\phi}\frac{r_2+4xk}{4\sqrt{xk}}\sin\sqrt{\frac{k}{x}}\varphi$$

or, neglecting terms of secondary magnitude:

$$\left.\begin{aligned} i''' &= \frac{E}{z}\,\varepsilon^{-(r/2x)\phi}\cos(\omega+j)\cos\sqrt{\frac{k}{x}}\varphi \\ e_1''' &= \frac{E\sqrt{xk}}{z}\,\varepsilon^{-(r/2x)\phi}\cos(\omega+j)\sin\sqrt{\frac{k}{x}}\varphi \end{aligned}\right\} \quad (36)$$

That is, i''' is of the magnitude of short-circuit current, and e_1''' of higher magnitude than the impressed electro-motive force, since z is small compared with $\sqrt{xk}$.

The total values of current and condenser potential difference are, from equation (26):

$$\left.\begin{aligned} i &= -\frac{E}{k}\sin(\varphi-\omega)+E\,\varepsilon^{-(r/2x)\phi}\left\{\left[\frac{\cos(\omega+j)}{z}\right.\right. \\ &\quad \left.\left.-\frac{\sin\omega}{k}\right]\cos\sqrt{\frac{k}{x}}\varphi+\frac{\cos\omega}{\sqrt{xk}}\sin\sqrt{\frac{k}{x}}\varphi\right\} \\ e_1''' &= E\cos(\varphi-\omega)-E\,\varepsilon^{-(r/2x)\phi}\left\{\cos\omega\cos\sqrt{\frac{k}{x}}\varphi\right. \\ &\quad \left.-\frac{\sqrt{kx}\cos(\omega+j)}{z}\sin\sqrt{\frac{k}{x}}\varphi\right\} \end{aligned}\right\} \quad (37)$$

or approximately, since all terms are negligible compared with i''' and e_1''':

$$\left.\begin{aligned} i &= \frac{E}{z}\,\varepsilon^{-(r/2x)\phi}\cos(\omega+j)\cos\sqrt{\frac{k}{x}}\varphi \\ e_1 &= \frac{E\sqrt{xk}}{z}\,\varepsilon^{-(r/2x)\phi}\cos(\omega+j)\sin\sqrt{\frac{k}{x}}\varphi \end{aligned}\right\} \quad (38)$$

These values are a maximum, if the circuit is open at the moment: $a = -j$, that is at the maximum value of the short-circuit current, and are then:

$$\left.\begin{aligned} i &= \frac{E}{z}\,\varepsilon^{-(r/2x)\phi}\cos\sqrt{\frac{k}{x}}\varphi \\ e_1 &= \frac{\sqrt{xk}}{z}E\,\varepsilon^{-(r/2x)\phi}\sin\sqrt{\frac{k}{x}}\varphi \end{aligned}\right\} \quad (39)$$

The amplitude of oscillation of condenser potential difference is:

$$\frac{\sqrt{xk}}{z}E$$

or, neglecting the line resistance, as rough approximation: $x = z$:

$$\sqrt{\frac{k}{x}}E$$

That is, the potential difference at the condenser is increased above the impressed electro-motive force in the proportion of the square root of the ratio of capacity reactance to inductive reactance, or inverse proportional to the square root of inductance voltage times capacity current, as fraction of impressed voltage and full load current.

Thus, in this case the rise of voltage is excessive.

The minimum intensity of the oscillation due to rupturing short-circuit occurs if the circuit is broken at the moment: $a = 90° - j$, that is, at the zero value of short-circuit current. It is then:

$$\left.\begin{aligned} i &= \frac{E}{k}\cos(\varphi+j)-E\,\varepsilon^{-(r/2x)\phi}\left\{\frac{\cos j}{k}\cos\sqrt{\frac{k}{x}}\varphi\right. \\ &\quad \left.-\frac{\sin j}{\sqrt{xk}}\sin\sqrt{\frac{k}{x}}\varphi\right\} \\ e_1 &= E\sin(\varphi+j)-E\,\varepsilon^{-(r/2x)\phi}\sin j\cos\sqrt{\frac{k}{x}}\varphi \end{aligned}\right\} \quad (40)$$

That is, the potential difference at the condenser is less than twice the impressed electro-motive force, thus moderate.

Hence, a short-circuit can be opened safely only at or near the zero value of the short-circuit current.

The phenomenon ceases to be oscillating, and becomes an ordinary logarithmic discharge, if $\sqrt{r_2-4xk}$ is real, or:

$$r > 2\sqrt{xk}.$$

American and German Commerce.

Some figures recently issued by the United States Treasury Bureau of Statistics show the growth of commerce between the United States and Germany. The increase in imports from Germany during the past 30 years has been nearly 300 per cent, while exports have increased nearly 400 per cent during the same period. The greatest growth in exports has taken place during the last five years, during which time the exports of agricultural implements have risen from $556,914 to $2,677,319, and machinery of all kinds from $1,595,135 to $8,109,095. Of the imports the articles which have shown the greatest growth are coal-tar colors and dyes, chemicals, laces, earthenware and sugar. Coal-tar colors and dyes have increased from $1,272,275 in 1891 to $3,822,162 in 1900, and other chemicals from $1,868,988 to $3,968,116. The total imports and exports during the last 30 years are shown in the following table:

Fiscal year.	Imports into U. S. from Germany.	Exports from U. S. to Germany.
1870.....	$27,015,321	$42,288,877
1875.....	40,247,712	40,466,025
1880.....	52,211,237	57,062,263
1885.....	63,241,753	62,222,791
1890.....	98,837,683	85,563,312
1891.....	97,316,383	92,795,456
1892.....	82,907,553	105,521,558
1893.....	96,210,203	83,578,988
1894.....	69,387,905	92,357,163
1895.....	81,014,065	92,053,753
1896.....	94,240,833	97,897,197
1897.....	111,210,614	125,246,088
1898.....	69,697,378	155,029,972
1899.....	84,225,777	155,772,179
1900.....	97,374,700	187,347,889
1901.....	100,293,666	191,072,252

The American Street Railway Association—II.

The Most Successful and Interesting Convention in the History of the Organization—The Fine Exhibit of Railway Appliances and Machinery at Madison Square Garden, New York—Sessions and Incidents of the Conventions—Entertainments and the Trip to the Bethlehem Steel Works.

THE TWENTIETH annual convention of the American Street Railway Association was held in New York city last week. Of all the meetings of this important body perhaps this one was the most interesting and significant, while it is beyond question that the exhibit of railway appliances and apparatus held in the Madison Square Garden in connection with it was the best that has ever been made. The convention met on Wednesday and Friday, October 9 and 11, the intervening day, October 10, being given over to inspection of the exhibits, and October 12 being pleasantly passed in a visit to the fine works of the Bethlehem Steel Company, at Bethlehem, Pa. The first day's session was reported in detail in the ELECTRICAL REVIEW for last week.

THURSDAY, OCTOBER 10.

The day was given over to an inspection of the superb exhibition of electric railway apparatus held in the great hall of the Madison Square Garden.

For several years past it has been the custom of the various manufacturers and supply dealers of the country to hold an exhibition in connection with the conventions of the Street Railway Association. Beginning with the exhibit of such appliances and supplies as could conveniently be shown in the limited space at disposal in hotels, the increasing magnitude of electrical apparatus employed on street railways some years ago forced those interested to engage more spacious quarters for the proper exhibition of their manufactures. With each session of the association this exhibit has grown in interest and importance, until this year, at New York, it may fairly be said that the exhibition surpassed not only any of similar kind that has been held in the past, but both in magnitude, interest and importance was the best electrical exposition that has been held in the United States for several years. While entirely devoid of the spectacular features common to electrical expositions and primarily intended to interest the general public, this purely professional exhibit comprised an entirely unique display of all of the various appurtenances entering into the physical operation of electric street railways, from tracks to trolley wire, and from advertising signs to power-house equipment. The immense space of the Madison Square Garden was entirely filled with exhibits and it was necessary to construct a gallery nearly a thousand feet long around three sides of the great building to accommodate exhibits for which room could not be found upon the floor. Taken altogether, this really astonishing display may be regarded as an index of the extraordinary prosperity of the electric railway industry and the allied trades in the United States.

MR. H. H. VREELAND, THE NEW PRESIDENT OF THE AMERICAN STREET RAILWAY ASSOCIATION.
(Photo by Davis & Sanford, New York.)

The only regrettable feature about the occasion was the necessity for bringing the fine display to an abrupt close at the termination of the convention's sessions. All day long Thursday interested groups of delegates were to be seen moving about through the various exhibits, while the occasion drew together perhaps the largest number of street railway and electrical engineers, operators and managers that has been assembled at any time in the history of the art. In succeeding pages will be found a detailed description of certain of the more striking exhibits and some further account of the various appliances and apparatus shown.

FRIDAY, OCTOBER 11.

The morning session was called to order by President Holmes.

Secretary Penington announced that the following-named companies had joined the association:

Altoona, Pa.—Altoona & Logan Valley Electric Railway Co.
Ashtabula, Ohio—Pennsylvania & Ohio Railway Co.
Atlanta, Ga.—Atlanta Traction Co.
Belleville, Ill.—St. Louis & Illinois Suburban Railway Co.
Cleveland, Ohio—Lake Shore Electric Co.
Denison, Tex.—Denison & Sherman Railway Co.
Grand Rapids, Mich.—Grand Rapids, Holland & Lake Michigan Rapid Railway Co.
Hancock, Mich.—Houghton County Railway Co.
Kenosha, Wis.—Kenosha Street Railway Co.
Little Rock, Ark.—Little Rock Traction and Electric Co.
Maynard, Mass.—Concord, Maynard & Hudson Railway Co.
Oneida, N. Y.—Oneida Railway Co.
Plymouth, Mass.—Plymouth & Brockton Street Railway Co.
Providence, R. I.—Providence & Danielson Railway Co.
Pittsburgh, Pa.—Pittsburgh, McKeesport & Connellsville Railroad Co.
Richmond, Va.—Richmond Passenger and Power Co.
San Antonio, Tex.—San Antonio Railway Co.

Mr. E. G. Connette then read his paper entitled "The Best Manner and Mode of Conducting the Return Circuit to the Power-House." The paper was an argument for an independent metallic return used in connection with the single overhead trolley system, as opposed either to the double trolley or bonded rail circuits.

The discussion was opened by Mr. E. P. Roberts, of Cleveland. He laid special stress on the necessity for good cross-bonding, and frequent tests should be made of the conductivity of the return system.

Mr. L. E. Myers, of Peoria, commended the points made in Mr. Connette's paper, and Mr. W. E. Harrington, of Camden, spoke at some length on the subject of bonding. He related the experience of the Camden street railways and described the expensive but very efficient bond in use there. Mr. Harrington did not think that auxiliary copper returns are called for in most cases. He inclined to the belief that rail bonding, if it was well done, was good enough. Mr. Pestell, of Worcester, Mass., described conditions in his town, in which good bonding was sufficient without copper returns. Mr. Uhlenhaut, of Pittsburgh,

said that he thought geographical location had a good deal to do with the situation. He described the conditions at Pittsburgh, where cross-currents run from one side of the town to the other through water and gas pipes, and in this case auxiliary bonds and return feeders were found necessary.

The discussion at this point was suspended on account of the length of the remaining programme, and the paper by Mr. W. E. Harrington, entitled "The Value of Storage Batteries as Auxiliaries to Power Plants," was read by its author.

Mr. Harrington's paper was long and very interesting, and was illustrated by numerous diagrams. He brought out the peculiar advantage of a storage battery on a railway installation as a lightning arrester. A number of tests were given, and, in general, a strong case made for the storage battery as a proper auxiliary for railway power stations.

Colonel N. H. Heft opened the discussion by saying that the experience of his company with eight installations was such that he could not recommend installing others until the manufacturers made a type of cell cheaper to maintain. In reply to questions Colonel Heft described the conditions under which the batteries were installed and operated. He stated that the principal maintenance cost was the expense for new plates.

Mr. Uhlenhaut thought the question of the amount of work the battery was required to do is the determining element in the whole matter. The discussion was continued by Mr. Wason, Mr. Davis, Mr. Roberts, Mr. O. T. Crosby, Mr. Harrington and the president. The report of the Committee on Standardizing was then read by Mr. Graham as follows:

Your committee on standardizing of street railway materials and equipments, appointed by the executive committee at its meeting held in New York city, February 28, 1901, respectfully presents the following report:

Three meetings of the committee have been held—Niagara Falls, June 3; New York, September 14, and Boston, September 18. At the first meeting the work was divided and assigned to the members of the committee, as follows:

Rails and wheels, axles, journals, journal brasses, oil boxes, etc., to N. H. Heft and F. G. Jones.

Car bodies, to John R. Graham.

Electrical equipment, to W. J. Hield.

Overhead equipment, to C. F. Holmes.

GENERAL VIEW OF THE CENTRE AND SOUTHEASTERN CORNER OF THE MADISON SQUARE GARDEN STREET RAILWAY EXHIBIT.

Track rails—We recommend a T-rail as the most desirable under any conditions. The rail-head should be of the form and dimensions shown in Fig. 1. With a rail-head of this form and dimensions, a car wheel having a three-inch trend and a flange of one five-sixteenth-inch depth, as shown in Fig. 2, can be operated without interfering with the pavement in cities, and with safety on suburban roads, at a minimum cost for track maintenance.

We recommend for a grooved girder rail, one with a head three inches wide, angle and groove as shown in Fig. 3. With a head of this form and dimensions, the same car wheel can be operated without interfering with pavements with safety on suburban roads, and with less cost for maintenance than the present form, due to increased surface of contact between wheel and rail

General View of Westinghouse Exhibit, Showing Nernst Lamps (in Foreground) and Car Equipped with Magnetic Track Brakes

Looking Down from the Southwestern Gallery at the Madison Square Garden Street Railway Exhibits.

and decreased wear on flange. This form of groove will decrease wear on side of railhead and allow wheels to be pressed on axle further than in common practice at the present time, thereby decreasing wear on rails at curvatures and the liability to mount rail.

Car wheels—We recommend a car wheel with a plate centre and cast-chilled tire for all speeds up to fifty miles per hour. When a greater speed is required we would recommend a steel tire, as shown by blue print marked exhibit E; tread to be not less than three inches; depth of flange, minimum, three-quarters inch, maximum, one inch; strengthened on back of flange. For full dimensions see Fig. 4.

Axles—We recommend the open-hearth steel axle, upset at point of gear wheel fit one inch, to allow the cutting key seat above the line of wheel fit, as shown in Fig. 5.

Journal brasses—We recommend Master Car Builders' journal brasses of the type shown by blue print marked exhibit G.

Brake-head and shoes—We recommend Master Car Builders' brake-head and shoes, as shown by blue print marked exhibit H.

Journal boxes—We recommend the Master Car Builders' journal boxes, as shown by blue print marked exhibit J.

Car bodies for city and suburban service—Your committee recommends a closed car body, mounted on a single truck, not to exceed twenty feet in length, believing this to be the maximum length for a car body mounted on a single truck. The general dimensions of the car are shown by drawings herewith submitted.

Car bodies for city service—A twenty-five foot closed car body, thirty-five feet over all, with concave sides, mounted on double trucks, as shown by drawings herewith submitted and general dimensions thereto attached.

Car bodies for suburban service from centre of population—A thirty-foot straight side closed car body, forty feet over all, mounted on double trucks, as shown by drawings herewith submitted and general dimensions thereto attached.

Open-car body for city and suburban service—A ten-bench open-car body, thirty feet over all, mounted on a single truck, as shown by drawings herewith submitted and general dimensions thereto attached.

A twelve-bench open-car body, thirty-five feet over all, mounted on double trucks, as shown by drawings herewith submitted and general dimensions thereto attached.

Oval roof—Your committee recommends for consideration the advisability of constructing all open cars with an oval, instead of a monitor, roof. We recommend this for consideration on the ground of economy in first cost and maintenance.

Painting—Your committee believes that a uniform system of painting can be adopted, but deems it advisable to obtain the views of the members of the association, as to their individual requirements, before submitting suggestions for a standard.

Ventilation—Your committee realizes that the question of ventilation in all closed cars is very important, but we do not feel justified, at this time, in recommending any particular system, feeling that this question should be brought before the convention for a thorough discussion to assist any future committee in preparing its report.

Electrical equipment—This is one of the most important subjects, and should be taken up more thoroughly than is possible at this time. The extent to which the standardizing of electrical equipment may be carried is limited to the general dimensions of the parts and their location, with reference to the other parts of the equipment. The work of standardizing should be carried out on the lines established by the present practice.

The subdivisions of the above report, dealing with these subjects respectively, are submitted as the report of the entire committee and not as the report of any individual member. All matters presented were discussed and agreed upon by the committee as a whole, and are presented as its joint action.

It is hardly necessary to say that the work in hand is of great magnitude and surrounded with many difficulties, owing to the varying conditions which exist on street railway systems, and that it can not well be expected that in this, the first report of the committee, it will be possible to definitely decide on standards for all classes and kinds of equipments.

This report is submitted simply as suggestions, in order to fully bring the question of standardizing before the association. Your committee recommends that the work be continued through such committee as the association may deem wise to appoint.

JOHN R. GRAHAM, chairman,
N. H. HEFT,
FRANK G. JONES,
WILLARD J. HIELD.

Dated, New York, October 9.

Considerable discussion ensued upon the report. Mr. John I. Beggs discussed the report at length and the question of appointing another committee to carry on the work was also argued at some length. Mr. Beggs incidentally spoke of the importance of T-rail construction being recognized as standard and related the excellent experience that had been had in Milwaukee with this type of equipment. His suggestion, during his remarks, that another association should be formed, to take in only the engineering and mechanical personnel of street railways, so that discussions concerning matters in their field could be had freely, was received with enthusiastic applause by the members present. After considerable discussion the report was received and filed, with the recommendation that the new committee be appointed by the new executive committee. Adjournment was then taken until the afternoon.

The afternoon session was opened by the reading of a paper entitled "The Modern Power-House, Including the Use of Cooling Towers for Condensing Purposes," by Mr. J. H. Vail, of Philadelphia. The discussion was opened by Mr. O. T. Crosby, and was participated in by Colonel N. H. Heft, Mr. Harrington, Mr. H. M. Sloan, of Chicago, Mr. Uhlenhaut and the president.

Mr. W. M. Pestell, of Worcester, Mass., then presented his paper, entitled "The Adoption of Electric Signals on Suburban and Interurban Railroads, Single or Double Track, and Their Economy of Operation." The discussion was opened by Mr. I. A. McCormack, of Cleveland. He spoke of the importance of the question of signals and earnestly stated his belief that interurban railroads operating at high speed must get down to steam railroad practice in this particular.

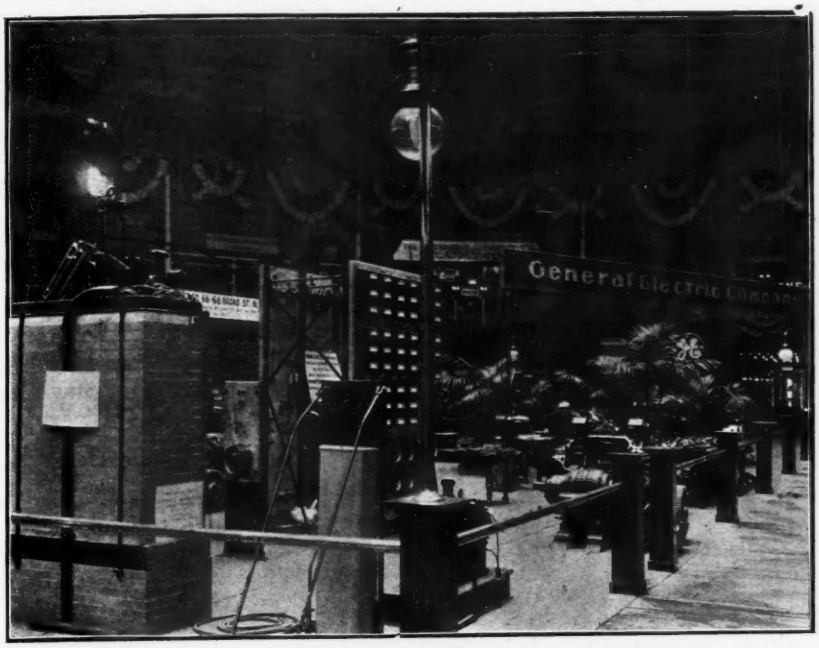
Mr. H. H. Vreeland, of New York, spoke of a plan that had been urged upon him to organize a telephone train despatching system. He asked the man who had proposed this for the Metropolitan Street Railway to go down to South Ferry and see the opportunities conductors enjoyed at that point for using the telephone. The man never came back. Mr. Vreeland spoke of a suburban line at Vancouver, British Columbia, which is operated very satisfactorily upon a steam railroad train despatching basis. He did not think the average of suburban railroads are operated as they should be in the interest of safety. His conclusion, after several experiences, was that steam railroad signaling systems should be used wherever high-speed electric railroads are operated in the country. Mr. Wheatly then spoke at some length on the necessity for signals, both in single and double-track operation. Mr. Fuller agreed with Mr. Wheatly that the time was coming when the block signal system will have to be installed on high-speed roads. Mr. Wason, of Cleveland, spoke of the disadvantages under which suburban roads are running from the lack of proper signals. The discussion was continued by Messrs. Fuller, C. E. Baker, Colonel Heft, C. S. Sargent, who described the organization of the elevated service in Boston, Harrington, Powers and the president.

The report of the nominating committee was then received, the following-named gentlemen being placed in nomination: President, H. H. Vreeland, New York; first vice-president, C. W. Wason, of Cleveland, Ohio; second vice-president, E. C. Foster, Boston; third vice-president, H. M. Sloan, Chicago; secretary and treasurer, T. C. Penington. Executive committee—W. H. Holmes, John A. Rigg, D. B. Dyer, T. J. Nicholl, G. W. Dickinson. The committee recommended the acceptance of an invitation received from the Everett-Moore Syndicate to hold the next convention at Detroit, Mich. In accordance with the usual custom the secretary was empowered to cast the vote for the association for the nominations as read and similarly to accept the invitation to hold the convention at Detroit. A number of votes of thanks were then passed and President Holmes made a few remarks in reply. Mr. Cooper then spoke concerning the matter of transportation of mail on electric street cars and offered a resolution requesting the appointment of a committee to memorialize Congress to increase the appropriation for that purpose. Mr. Vreeland said that he had absolutely refused to take the mail business in New York city on a non-paying basis. He was not in favor of the association putting itself on record of sending the

memorial to Congress to ask them to do something which they should do before the street railways undertake the mail business. Mr. Wheatly spoke of the conditions in Brooklyn and, upon motion, the matter was referred to the executive committee for further action.

After a unanimous vote of thanks to the supply men for the magnificent exhibit which they had conducted, the session was adjourned to reconvene at the banquet in the evening.

On Friday morning, through the courtesy of Mr. Henry Sanderson, president of the New York Electric Vehicle Transportation Company, the ladies accompanying the delegates to the convention to the number of nearly 300 were taken on an automobile ride around New York city and to a luncheon at Claremont.



View of the General Electric Company's Exhibit, Showing Oil-Break High-Tension Switch (at Left).

THE BANQUET.

The twentieth annual dinner of the American Street Railway Association was given at Sherry's, Friday evening, October 11, 1901. Very beautiful menus were provided, embossed in gold and printed in colors, and illustrated with pictures of ancient and modern street cars.

Toasts were responded to as follows:

"Our Friends, the Steam Railroads," Hon. C. S. Gleed.

"The Technical Press," Mr. T. Cummerford Martin.

"The Kickers," Mr. Simeon Ford.

"West Point and Annapolis," General Eugene Griffin.

"The Mule in the Field of Traction," Hon. John S. Wise.

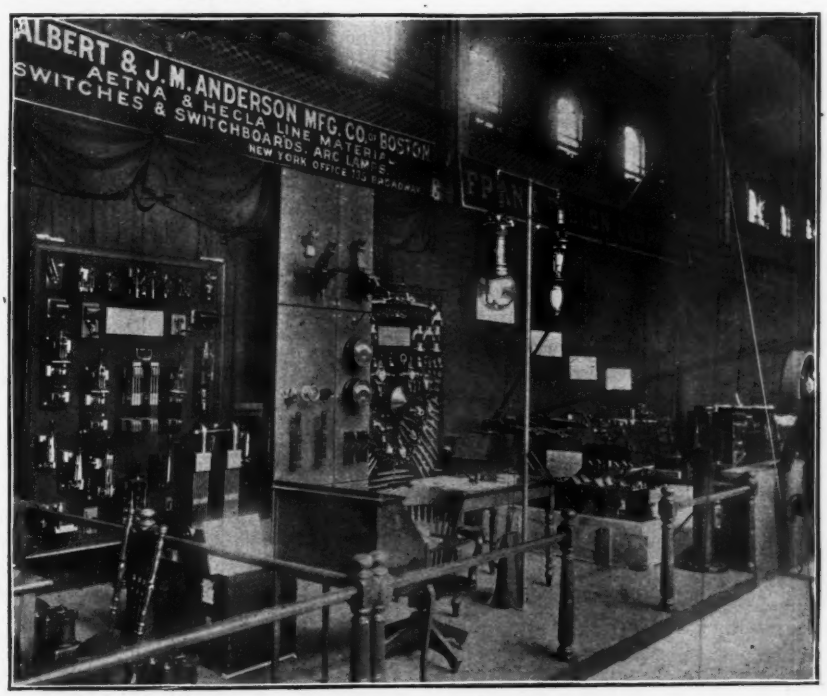
"The Street Railway in Law and Politics," Hon. Job E. Hedges.

"The Only Railroad Man I Ever Knew," Mr. Martin W. Littleton.

Hon. Randolph Guggenheimer, who was to have responded to the toast "Greater New York," sent a letter instead, as he was unable to be present.

The banquet was a particularly fine one, and the addresses were instructive and entertaining. At the conclusion of the dinner, President-elect Vreeland and his fellow officers were installed.

A number of the visiting ladies dined in an adjoining room, and listened to the speeches from the gallery of the main hall.


ALBERT & J.M. ANDERSON MFG. CO. OF BOSTON
AETNA & HECLA LINE MATERIAL
SWITCHES & SWITCHBOARDS, ARC LAMPS
NEW YORK OFFICE 114 NASSAU

Two Typical Exhibits in the North Gallery.

THE TRIP TO SOUTH BETHLEHEM.

On Saturday morning about 200 of the delegates and others interested took a special train on the Lehigh Valley Railroad to South Bethlehem, Pa., where an inspection of the magnificent plant of the Bethlehem Steel Company was made. The party arrived at its destination about 10.30 A. M., and debarking from the special train, which had brought them at high speed from New York, were put on observation cars and taken through the works. The first point of general interest was the blast furnaces, one of which was being tapped into large ladles as the party passed it. These ladles were run several hundred yards down a track by locomotives and there discharged into an interesting casting machine which converted the molten material into pig iron. The train then moved past the armor-plate department and out to a corner of the works where an immense unloading and conveying machine was shown in operation, handling ore from cars into storage piles. From this point the train returned to the annealing building, where the operation of oil tempering a large gun tube was exhibited. The next stopping point was in front of the open-hearth furnaces, where a furnace was tapped, the molten steel

being conveyed to a gigantic ingot mould, where it was subjected to a pressure of 7,000 tons in order to consolidate it.

The next point of interest, and probably the most interesting of all, was the forge, where two hydraulic presses, one of 2,500 tons and the other of 5,000 tons, were at work forging hollow shafts of large dimensions. Passing from this plant the annealing shops were visited, and the party were then disembarked at the gate of machine shop No. 2, which is the largest institution of its kind in the world. Here were exhibited large commercial forgings, as well as parts of guns and armor plate undergoing machine operations, and a very large number of machine tools of the most gigantic dimensions in full operation. Special interest was exhibited in the tool steel, itself made at the Bethlehem works, which is used in this shop and which permits machine tools to be run at a higher speed than they are operated anywhere else. Indeed, this speed is so high that a chip turned up from a gun forging, for example, is heated to a blue color in the operation. The gun department of the shop was also very interesting to the visitors, guns up to sixteen-inch bore being seen in all stages of completion. After a pleasant hour spent in this shop the guests were escorted to the works' dining-room in the office building, where luncheon was served. The guests then embarked again on the observation train and were taken to the railway station, where, reentering their special train they were taken back to New York in almost record time, making practically no stops. The visit was not only enjoyable to an extreme degree, but highly instructive, as nowhere in the country can be seen more titanic machinery in operation than at these splendid works. The excursion was organized through the courtesy and under the immediate supervision of Mr. H. F. J. Porter, the New York representative of the Bethlehem Steel Company.

No account of this convention would be complete without reference to the courtesy, interest and ability displayed by the various committees having charge of the local arrangements, and especially by Mr. H. H. Vreeland, president of the Metropolitan Street Railway Company and the newly elected president of the association. Nothing was left undone that could add to the convenience and comfort of the visiting delegates, and it is beyond doubt that this meeting in New York will long be remembered as one of the most thoroughly enjoyable, instructive and important in the history of the organization.

EXHIBITS AND EXHIBITORS.

THE MAYER & ENGLUND COMPANY, PHILADELPHIA—General railway supplies, etc. Representatives: F. H. Works, A. H. Kittredge, C. D. Townsend, J. B. Losey, H. E. Sargent, S. Y. L'Hommedieu.

R. D. NUTTALL COMPANY, PITTSBURGH—Trolley pole equipments, street car gears, special gears. Representatives: F. A. Estep, L. W. O'Brien.

DUFF MANUFACTURING COMPANY, ALLEGHENY—Barrett jacks. Representatives: J. Sherborne Singer and Mr. Freed.

FRANK RIDLON COMPANY, BOSTON—Weld babbitting device, Wilson trolley pole catcher, Kilbourn track sanding device, Ridlon track drill. Representatives: Frank Ridlon, C. N. Wood, N. L. Wood, Harry Kellog, Robert Mathias.

ALBERT & J. M. ANDERSON MANUFACTURING COMPANY, BOSTON—Monarc arc lamps for trolley circuits, line material, switches and switchboards. Representatives: Albert Anderson, Ernst Woltman, Robert Kilpatrick.

MERRITT AIR BRAKE COMPANY, NEW YORK—Air brake equipments for street cars. Representatives: F. W. Merritt, Jabez Gilbert.

ATLAS RAILWAY SUPPLY COMPANY, CHICAGO—Atlas rail joints, braces, tire plates, Atlas primer and surfacer for cars, paints for all kinds of wood, iron and trolley poles. Representatives: J. G. McMichael, R. B. Kent.

NATIONAL LEAD COMPANY, NEW YORK—Phœnix metal. Representative: J. Robert Boyd.

THE OHIO BRASS COMPANY, MANSFIELD, OHIO—Electric railway supplies, Dirigo insulation, attachments for all designs of wire, pole brackets, fender car scraper. Representatives: C. K. King, secretary; G. A. Harwood, R. A. Byrnes, A. B. Edes, M. A. Berg, George A. Meade, B. Gellatly, A. L. Wilkinson.

STANDARD VARNISH WORKS, NEW YORK—Insulating varnishes. Representatives: E. L. Phillips, John C. Dolph.

W. H. COE MANUFACTURING COMPANY, PROVIDENCE—Ribbon gold and aluminum leaf, Coe's gilding wheels. Representatives: C. H. Powers, E. C. Weekes, Jr.

LOUIS S. TREADWELL, NEW YORK—Improved running board for open cars. Representative: George C. Treadwell.

BISHOP GUTTA PERCHA COMPANY, NEW YORK—Cables for light, power and submarine purposes insulated with both rubber and gutta-percha. Representatives: H. D. Reed, I. W. Smith, E. E. Price.

UNITED STATES ELECTRIC SIGNAL COMPANY, WATERTOWN, MASS.—Electric railway signals. Representatives: James Nickerson, Alfred E. Barbour, Dr. Frederick E. Withee.

UNION STOP AND SIGNAL COMPANY, FALL RIVER, MASS.—Despatcher signals, crossing bells, general electric signaling apparatus. Representative: O. W. Hart.

STANDARD PAINT COMPANY, NEW YORK—P & B armature and field coil varnish, P & B electrical compounds, P & B insulating tape, P & B insulating papers, ruberoid roofings, preservative paints. Representatives: Ralph L. Shainwald, president; James N. Richards, F. F. Vandewater, Charles Earnshaw, Boston; Alfred F. Georgi, Gustav Meyer, Hamburg, Germany; Edward Rich, Sidney, New South Wales.

NEW YORK TELEPHONE COMPANY, NEW YORK—Branch exchange switchboards. Representatives: J. Holder, M. C. Turner.

THE PITTSBURGH REDUCTION COMPANY, PITTSBURGH—Aluminum and aluminum wire. Representatives: S. K. Colby, New York; E. T. Brastow, New York; A. V. Davis, Pittsburgh; J. A. Rutherford, Cleveland; Charles May, Chicago; Percy Hodges, Boston; A. K. Lowie, Pittsburgh.

CREAGHEAD ENGINEERING COMPANY, CINCINNATI—Overhead line fittings, Creaghead flexible brackets, mast arms. Representatives: T. J. Creaghead, J. M. Kennedy, Jr.

THE HALE & KILBURN MANUFACTURING COMPANY, NEW YORK—Steam car seats, electric car seats. Representatives: S. A. Walker, H. T. Bigelow, Chicago.

THE CURTAIN SUPPLY COMPANY, CHICAGO—Samples of curtains and automatic fixtures. Representatives: W. H. Forsyth, general manager; A. L. Whipple, general sales agent.

THE ADAMS & WESTLAKE COMPANY, NEW YORK—Electric headlights. Representatives: Ward W. Willits, W. S. Bartholomew, E. H. Stearns, A. S. Anderson, J. H. Foster.

PANASOTE LEATHER COMPANY, NEW YORK—Car curtains, car seats, car head linings. Representatives: John High, Mr. Greer.

HEYWOOD BROTHERS & WAKEFIELD COMPANY, NEW YORK—Walkover car seats, revolving chairs, chairs in Brooklyn Heights railway car. Representatives: Bertram Berry, F. H. Henry.

AMERICAN CAR SEAT COMPANY, BROOKLYN—Rattan car seating without brass clips, interlocking springs. Representative: William M. Adler.

AMERICAN RAILWAY SUPPLY COMPANY, NEW YORK—Badges and buttons. Representative: Walter Chur, manager.

McLAUGHLIN CAR COUPLER COMPANY, PHILADELPHIA—M. C. B. automatic coupler for street railway cars. Representatives: C. H. McLaughlin, J. T. Riley.

W. T. VAN DORN COMPANY, CHICAGO—Automatic draw bars for street and elevated railways, master car builders standard coupling. Representative: W. T. Van Dorn.

POWELL & TURNER TRUCK COMPANY, TROY, N. Y.—New Century truck, Flood emergency brake and car holder. Representative: C. W. Powell.

STREETER BRAKE SHOE COMPANY, BLOOMFIELD, N. J.—Brake shoes. Representative: George Evans.

MORRIS ELECTRIC COMPANY, NEW YORK, represented the following companies, most of whom had also their own home representatives: Electric Railway Equipment Company—Pole brackets, pole arms, fancy lamp poles, trolley poles, mast arms, overhead line material, slow-feed controller handles. Representative: P. F. Harten. Erie Exploration Company—Erie electric car heater, current regulator. Representatives: James P. Erie, W. H. Miller. American Electric Switch Company—Controllers, rheostats, etc. Representative: W. S. Berry. Auto Electric Shunt Company—Series alternating and direct-current shunt lamps. Representative: F. W. Wise. Globe Electric Manufacturing Company—Multiplex reflector, arc headlight. Keystone Electrical Instrument Company—Switchboard, portable instruments. Representative: J. F. Stevens. Bierbaum & Merrick Metal Company—Ideal trolley wheel, bronze bearings. Representative: E. P. Sharp. McGuire Manufacturing Company—No. 35 double-truck equipment, No. 39 A, short-wheel base double-truck equipment, new sliding cushion fender, Royal flush fender. Representatives: P. E. Davenport, B. F. Stewart. Morris Electric Company exhibited railbonds, fare registers, overhead material, brass trimmings for cars. Representatives: George Ewing, president; E. P. Morris, treasurer, H. S. Sanville, secretary; H. DeSteese, salesman.

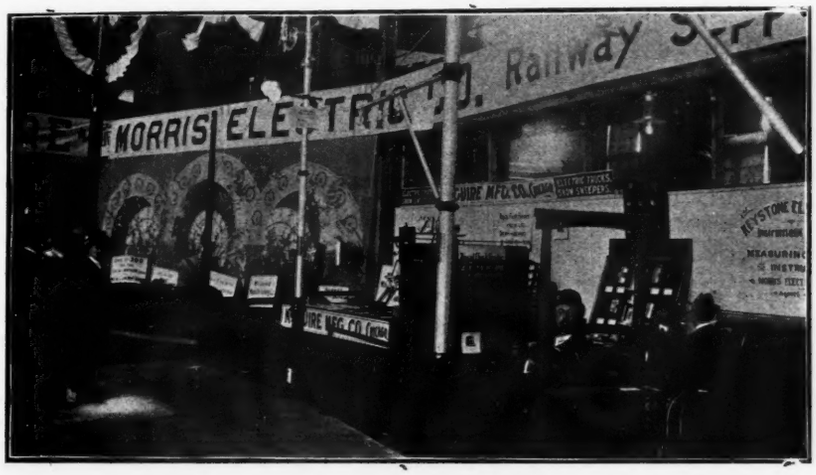
CONSOLIDATED CAR HEATING COMPANY, NEW YORK—Manhattan elevated heater, Boston elevated heater. Representative: C. S. Hawley, New York office.

BAY STATE ELECTRIC HEAT AND LIGHT COMPANY, BOSTON—Electric car heater, fan motor, low-watt lamps. Representatives: E. S. Gardner, superintendent; General B. F. Peach, treasurer; H. W. Gardner.

GOULD STORAGE BATTERY COMPANY, NEW YORK—Storage batteries, plates, battery in all lead antimony tank. Representative: William W. Donaldson.

GOLD STREET CAR HEATING COMPANY, NEW YORK—Electric car heaters. Representatives: John E. Ward, general manager; Fred Schmidt.

THE CONSOLIDATED CAR FENDER COMPANY, NEW YORK—Providence car fender, models A, B, C and D, Campbell snow broom head, Millen car step lifter. Representatives: John Sheppard, Jr., president; Colonel A. C. Woodward, general manager; George Hollingsworth, E. C. Hall.



IN THE SOUTHEASTERN CORNER OF THE GALLERY, MADISON SQUARE GARDEN, STREET RAILWAY EXHIBITION.

H. B. CAMP COMPANY, AKRON, OHIO—Single duct conduits for underground subway purposes. Representative: Mr. Beard.

AMERICAN VITRIFIED CONDUIT COMPANY, NEW YORK—Vitrified clay conduits, third-rail insulators. Representative: B. S. Barnard.

H. W. JOHNS MANUFACTURING COMPANY, NEW YORK—Moulded mica trolley line insulators, fuses, weatherproof sockets, vulcabeston, controller parts, field spools, bushings, electric car heaters, electrotherms, Monarch moulded insulation. Representatives: Joseph Sachs, J. E. Meek, S. G. Meek.

WILLIAM WHARTON, JR., & COMPANY, INCORPORATED, PHILADELPHIA—Manganese steel hard centre work, crossings, switches, frogs, cast weld comprised joints, pieces showing ductility of manganesed steel. Representatives: William Wharton, Jr., president; Victor Angerer, vice-president and general manager; Rodman Wharton, engineer; J. C. Robinson, Boston representative; L. Koppenhoeffer.

LORAIN STEEL COMPANY, LORAIN, OHIO—Special work, rail crossings, samples of rail sections, exhibition of electric welding, full electrical equipment controllers. Representatives: Major H. C. Evans, general eastern sales agent; P. M. Boyd, secretary; H. D. Bayne, Lorain; D. J. Evans, Chicago; S. P. S. Ellis, Pittsburgh; F. J. Drake, New York; E. B. Entwisle, chief engineer.

ELECTRIC CONTRACT COMPANY, NEW YORK—Light of Asia lamps. Representative: F. Smith.

THE G. P. MAGANN AIR BRAKE COMPANY, DETROIT—Straight air equipment, automatic motor car and trailer, automatic brake, system of charging cars from stationary tanks, exhibition of method of compressing air with motor-driven compressor. Representatives: E. C. Rutherford, manager; J. C. Grace, vice-president; W. K. Omick, superintendent; F. Y. Harrison.

THE METAL SALES COMPANY, CLEVELAND—General line of babbitt metal, renown anti-friction metal for high-speed machinery, Easty patent mandrel. Representative: Frank R. Marks, secretary and treasurer.

J. G. BRILL COMPANY, PHILADELPHIA—Section of convertible car, open car with double step, semi-convertible car, Brill No. 27 G truck, Brill No. 27 E truck, Brill No. 21 E single truck, Eureka Maximum Traction truck. Representatives: J. A. Brill, W. H. Huelings, Jr., S. Kerwin, D. B. Dean, G. M. Haskell, W. E. Partridge.

BROOKLYN HEIGHTS RAILROAD COMPANY, BROOKLYN—Side seat car with convertible seats. Representatives; Eugene Chamberlin, superintendent of equipment; T. Mulford.

ADAM COOK'S SONS, ALBANY, N. Y.—Albany grease, electric motor grease. Representatives: J. B. Merritt, J. Hernandez.

ST. LOUIS CAR COMPANY, ST. LOUIS—Anderson-Smith arc headlight, photographs of different types of cars, spiral journal bearings. Representatives: F. E. Huntress, general eastern agent; T. M. Reed, W. J. Floyd, C. S. Snow.

THE TAUNTON LOCOMOTIVE MANUFACTURING COMPANY, TAUNTON, MASS.—Snow plow for interurban work, nose plow, nose and brakes operated by air. Representatives: W. R. Billings, treasurer; H. L. Hepburn.

CHASE-SHAWMUT COMPANY, BOSTON—Electrical specialties. Representatives: G. L. Osborn, N. P. Hamlin, H. P. Moore, Frank Masterson.

PECKHAM MANUFACTURING COMPANY, NEW YORK—Four heavy service high-speed trucks, pair maximum traction trucks equipped with Price hydraulic friction brake, truck for city and suburban service in operation, excelsior single truck, metropolitan special truck. Representatives: E. Peckham, president; W. G. Price, engineer; B. R. Stare, superintendent of works; G. H. Bowers, secretary; E. G. Long, sales agent; A. W. Field, New England representative; J. A. Hanna, western representative; W. H. Stare, superintendent Price Brake Company; W. Boyer, assistant superintendent Price Brake Company.

ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA—Type G 53 chloride accumulator, type F 19 chloride accumulator in all-metal tank, type F chloride accumulator in glass, differentially wound-motor booster for railway regulation, standard railway switchboard panel, map of New York showing installations of chloride accumulators. Representatives: Charles Blizard, manager of sales department; Albert Taylor, manager New York office; F. L. Kellogg, W. O. Knudsen, E. L. Reynolds, J. L. Woodbridge, J. B. Entz.

SPRAGUE ELECTRIC COMPANY, NEW YORK—Two complete car equipments of multiple-unit system of train control, operating four motors, photographs of roads equipped with this system. Representatives: F. J. Sprague, F. H. Sheppard, selling engineer; G. H. Hill, electrical engineer; S. H. Libbey, factory engineer railway department; A. D. Campbell, superintendent construction; H. M. Davis, advertising agent.

CROCKER-WHEELER COMPANY, AMPERE, N. J.—500-kilowatt railway generator magnet frame; 200-kilowatt railway generator. Representative: F. B. DeGress, manager New York branch.

HAROLD P. BROWN, NEW YORK—Edison-Brown plastic rail-bond, complete outfit for testing rail-bonds, cross-bonds, feeder terminals, solid copper bonds, plug-bonds, solid alloy and flexible solder, portable drill, hand-power grinder. Representatives: H. P. Brown, James Hallowood, J. Maxwell Coote.

ROBINS CONVEYING BELT COMPANY, NEW YORK—Robins conveying belt for coal handling and distribution. Representative: J. F. Symington.

GLOBE TICKET COMPANY, PHILADELPHIA—Transfer tickets, fare tickets in strip form. Representatives: W. C. Pope, vice-president; D. C. Griffiths, P. C. Snow.

UNITED STATES STEEL COMPANY, NEW YORK—Neal duplex brake. Representatives: H. B. Whall, B. O. Gage, F. E. Laughton.

CONTINUOUS RAIL JOINT COMPANY, NEWARK, N. J.—Rail joints, step joints, sections of girder rail joints, T-rail joints, bonded joints. Representatives: L. F. Braine, general manager; H. M. Montgomery, Chicago; B. M. Barr, New York; W. C. Clark, Chicago; J. H. Brothers, Newark; J. H. Allen, Newark.

BALTIMORE CAR WHEEL COMPANY, BALTIMORE, MD.—Lord Baltimore truck. Representative: J. Paul Baker.

ROCHESTER CAR WHEEL WORKS, NEW YORK—Street car wheels of various sizes. Representatives: C. T. Chapin, president; F. D. Russell, vice-president; George C. Morse, general sales agent; E. H. Chapin, assistant to vice-president; A. H. Strickland, superintendent New York shop.

NEW PROCESS RAW HIDE COMPANY, SYRACUSE, N. Y.—Railway pinions. Representative: T. G. Meachen.

TAYLOR ELECTRIC TRUCK COMPANY, TROY, N. Y.—Standard single truck, extra heavy single truck, Empire State radial double truck, regular swing motion double truck, extra heavy swing motion double truck, short wheel base double trucks. Representatives: John Taylor, G. A. Tupper, Robert Kasson.

THE WEBER RAILWAY JOINT MANUFACTURING COMPANY, NEW YORK—Weber joints for T and girder rails, photographs of railways where these joints are used. Representatives: J. C. Barr, general sales agent, New York; G. L. Hall, engineer, New York; F. A. Poor, engineer, Chicago; E. F. Schermerhorn, New York.

PENNSYLVANIA STEEL COMPANY, STEELTON, PA.—Frogs and switches for steam and electric roads; photographs of bridges, buildings, etc., where its product has been used. Representatives: C. F. Clark, Boston; W. C. Cuntz, Boston; H. F. Marton, Steelton; W. A. Baldwin, New York; R. C. Hoffman, Baltimore; F. W. Edmunds, Chicago; George Parsons, Steelton.

CHRISTENSEN ENGINEERING COMPANY, MILWAUKEE—Street car brakes, four independent motor air compressors, complete automatic air equipment set up, one complete straight-air equipment set up. Representatives: N. A. Christensen, general manager; F. C. Randall, eastern representative; J. H. Denton, chief engineer; G. S. Hastings, western representative; J. T. Cunningham, C. P. Tolman, Henry Pels, German representative; W. A. Gratton, J. E. Eldred, Jr.

ARTHUR KOPPELL, NEW YORK—Narrow-gauge railway material for coal and ash transportation, light rails, light rolling stock. Representatives: Ernst Weiner, C. R. Gier, Jr.

HENRY PELS & COMPANY, NEW YORK—Shears and punches made of wrought iron and steel. Representative: Henry Pels.

KNELL AIR BRAKE COMPANY, BATTLE CREEK, MICH.—Knell accident air brake system. Representatives: Joel C. Hopkins, secretary; A. H. Metzelaar, sales manager; P. Hoffmeister, treasurer; W. F. Knell, construction engineer; J. R. Bunce, engineer.

THE OHMER CAR REGISTER COMPANY, DAYTON, OHIO—Three different fare registers. Representatives: John F. Ohmer, vice-president and general manager; W. B. Farnham, treasurer; J. H. Stedman, secretary; M. McDonald, general eastern agent; W. F. Breidenbach, manager of insulation; E. S. Atwood, New York state agent.

STERLING-MEAKER COMPANY, NEW YORK—Sterling safety brake, Sterling sand box, Sterling fender, several types of fare registers. Representatives: J. H. Carson, president; C. S. Ackley, secretary; E. B. McLean, manager; G. Dodge, superintendent; J. A. Stowe, treasurer; E. Wickwire, salesman.

THE INTERNATIONAL REGISTER COMPANY, CHICAGO—Fare registers and fittings. Representatives: A. H. Woodward, president; W. H. Brown, secretary.

NEW HAVEN CAR REGISTER COMPANY, NEW HAVEN, CT.—Fare registers, electric railways supplies. Representatives: W. M. Anthony, president; J. S. Bradley, secretary and treasurer; F. C. Boyd, vice-president; F. B. Kennedy, assistant secretary; J. M. Hayes, salesman; M. D. F. Yates, saleman.

GILES S. ALLISON, NEW YORK—Security and self-recording registers, electric tripartite poles, Valentine & Company's varnish. Representatives: G. S. Allison, G. B. Dovey, W. Kierchhoff, G. V. A. Conger, H. C. Donecker.

MAGNUS METAL COMPANY, BUFFALO—Magnus improved self-oiling trolley wheel, Magnus metal motor and generator bearings, Magnus anti-friction metal, babbitt metals, journal bearings for street cars. Representative: B. M. Tate, Buffalo.

FOWLER & ROBERT MANUFACTURING COMPANY, NEW YORK—Fowler & Robert fare registers. Exhibit of evolution from one machine to another. Representatives: J. W. Fowler, president; G. W. Linch, treasurer; E. Packer, salesman; F. A. Morrell, salesman.

AMERICAN CIRCULAR LOOM COMPANY, CHELSEA, MASS.—American circular loom. Representatives: R. B. Cory, H. B. Kirkland.

BRIDGEPORT BRASS COMPANY, NEW YORK—Phono-Electric wire. Representatives: H. G. Madden, W. Brown.

CHAPMAN DOUBLE BALL BEARING COMPANY, NEW YORK—Electric car ball bearings. Representatives: C. H. Chapman, president; H. C. Wilson, mechanical engineer.

MONARCH FIRE APPLIANCE COMPANY, NEW YORK—"Kilfyre" fire extinguisher. Representatives: C. H. Barney, P. L. Wilbur.

DIAMOND STATE STEEL COM-

PANY, NEW YORK—Track fastenings, patent articles, Church-Hill rail joint, Diamond tie-plates, Diamond State spike. Representatives: L. A. Bower, vice-president; J. A. Parker, sales agent, New York.

ALLSTON FOUNDRY COMPANY, BOSTON—Compo brake shoes with cork inserts, automobile pulley for band brake mechanism, machine pulleys with cork inserts, friction clutch, friction pulley with cork inserts. Representatives: W. W. Whitcomb, president; W. S. Sanborn.

THE KINNEAR MANUFACTURING COMPANY, COLUMBUS, OHIO—Kinnear steel rolling door with trolley wire connection. Representatives: F. C. Schmidt, W. H. Brodie, J. R. Brodie.

DALLETT & COMPANY, PHILADELPHIA—Second-hand railway motors. Representatives: Frank Dallett, C. F. Johnson.

MASON SAFETY TREAD COMPANY, NEW YORK—Safety treads for stairs. Representatives: Hermann Pfeffer, New York agent; T. R. Morrell, R. D. Weeks, C. H. Forsaith.

NATIONAL LOCK WASHER COMPANY, NEWARK, N. J.—Lock washers, sash locks, curtain fixtures. Representatives: W. C. Dodd, secretary; Daniel Hoyt.

F. H. NEWCOMB, BROOKLYN—Uniform caps. Representatives: F. H. Newcomb, E. P. Martin, Jr.

G. F. BRANDAU, UTICA, N. Y.—Brandau accident brake. Representatives: G. F. Brandau, C. W. Brandau.

PALM, FECHTELER & COMPANY, NEW YORK—Transfer Decalcomanie ornaments, transfer waining signs. Representatives: Frank Fechteler, James A. Fergusson.

THE AMERICAN TELEGRAPHONE COMPANY, NEW YORK—Telegraphone for train despatching. Representatives: C. A. Lieb, O. T. Crosby, E. W. Creecy.

NATIONAL CARBON COMPANY, CLEVELAND—Carbon brushes, Columbia carbon brush, Columbia dry cell, Columbia enclosed arc carbon for headlights. Representatives: H. J. Davies, secretary; A. E. Carrier, New York representative; R. K. Mickey.

PARTRIDGE CARBON WORKS, SANDUSKY, OHIO—Partridge self-lubricating motor brush. Representatives: J. T. Partridge, president; A. C. Henry, New York representative.

FRANCIS GRANGER, NEW YORK, represented the following companies together with his own exhibit: Hipwood-Barrett Car and Vehicle Fender Company, patent car fenders. Lehigh Car Wheel and Axle Works, car wheels. Sterling Electrical Works, incandescent lamps. Also the following: Running brake shoes, sand boxes, fare registers, Granger safety tread, trojan trolley fender, trolley catcher, punches, insulating tape. Representatives: Francis Granger, W. Hibbard, A. B. Dolby, E. J. Righter, H. Ham, A. W. Ham, A. M. Wight, N. H. Colwell, B. F. Swartz, J. B. Terbell, H. T. Mercur, C. Graham Bacon.

UNITED STATES PROJECTILE COMPANY, BROOKLYN—Projectile brand high carbon gears and pinions. Representatives: C. E. Porter, B. W. Stone, L. E. Robert.

THE VAN DORN AND DUTTON COMPANY, CLEVELAND—Gears, pinions, armature lifts. Representative: W. A. Dutton.

THE VAN DORN-ELLIOTT ELECTRIC COMPANY, CLEVELAND—Armature and field coils, commutators, rewound armatures. Representative: W. H. Elliott.

RELIANCE MANUFACTURING COMPANY, BROCKTON, MASS.—The Valentine block signal and crossing signal, automatic spacer for spacing cars on a double track, circuit-breaker. Representative: D. Valentine.

BRADY BRASS COMPANY, JERSEY CITY—Motor bearings, journal bearings, check plates, trolley wheels, anti-friction metal, solder, brass castings, Cyprus and phosphor bronze. Representatives: D. M. Brady, president; C. P. King, saleman; C. M. Reubens, F. C. Cameron, E. F. Wilmerding.

CRANE COMPANY, CHICAGO—Gate valves, globe valves, flanged and screwed fittings, oil cups, grease cups, air cocks, bib cocks, compression cocks, whistles, check valves, relief valves, angle valves, hose nozzles. Representatives: B. A. Kimburg, T. R. Rourke.

DEARBORN DRUG AND CHEMICAL WORKS, CHICAGO—Pyramid of barrels showing style of package used, high-grade lubricating oils, display of boiler scale. Representative: R. F. Carr, vice-president and general manager; W. B. McVicker, eastern manager.

STUART-HOWLAND COMPANY, BOSTON—Trolley wheels, brushes, gears, pinions, headlights, arc lights, line material, uniform buttons, badges, punches, incandescent lamps, car trimmings. Representatives: H. W. Smith, assistant manager railway department; W. M. Wampler, New York representative.

COLUMBIA MACHINE WORKS, BROOKLYN—Electric railway supplies, commutators, trolley wheels, brush holders, brush springs, controller handles, reverse handles, brake handles, patent anchors, Millen illuminated car sign, car trimmings, conductors' bells, motor gongs, axle and armature bearings. Representatives: J. G. Buehler, J. Grady, C. Love, R. Kane.

THE CUTTER COMPANY, PHILADELPHIA—Circuit-breakers. Representative: G. N. Anable.

SPEER CARBON COMPANY, ST. MARYS, PA.—Carbon specialties, carbon brushes, etc. Representatives: J. S. Speer, Andrew Kaul.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.—Type M control for electric railway motors in actual operation, incandescent lamps being substituted for motors. Electrically operated oil circuit-breaker shown in operation; direct and alternating-current switchboard panels; section of underground conduit; two large 125-horse-power motors; railway motors of various types; electric brakes, grooved trolley wire and line material; collection of various repair parts and supplies. Representatives: J. R. Lovejoy, W. B. Potter, R. H. Beach, C. C. Pierce, J. J. Mahoney, E. H. Mullin, T. P. Bailey, J. W. Buell, R. E. Moore, S. W. Trawick, F. H. Strieby, G. D. Rosenthal, F. F. Barbour, J. C. Calisch, H. H. Corson, F. Cutts, J. G. Barry, A. H. Armstrong, T. B. Whitted.

AMERICAN ELECTRIC HEATING CORPORATION, BOSTON—Electric heating apparatus designed for car heating purposes. Also appurtenances such as switches, etc. Representative: Roger Williams.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, PITTSBURGH—No. 49 railway motor, open; No. 50 railway motor, one closed and one open; No. 56 railway motor, one closed and one open; No. 68 railway motor, one closed and one open; No. 76 railway motor, one closed and one open; No. 81 railway motor, open; Peckham truck, equipped with two No. 49 Westinghouse railway motors; Brill maximum traction truck, equipped with Westinghouse No. 81 railway motor; Baldwin-Westinghouse mine locomotive; railway power station switchboard; illuminated dial ammeter; illuminated dial voltmeter; round-type ammeter; round-type voltmeter; D. C. station lightning arrester; street car lightning arrester with choke coil; canopy switch; canopy circuit-breaker; car fuse boxes; car diverter; car diverter column, partly assembled to show construction; gears, gear cases, pinions, axle bearings; Nernst lamps; car with standard air brakes in operation on track. Representatives: B. H. Warren, J. R. Ellicott, Arthur Warren, T. H. Taylor, W. M. Probasco, of Pittsburgh, Pa.; C. W. Regester, Chicago, Ill.; C. A. Bragg, Philadelphia, Pa.; Paul T. Brady, Syracuse, N. Y.; T. C. Frenyear, Buffalo, N. Y.; Calvert Townley, Boston, Mass.; H. H. Westinghouse, John F. Miller, E. M. Herr, of Pittsburgh, Pa.; Andrew J. Breslin, Edward E. Pettee, John J. McCutchen, of New York city; William R. Hurd, of Boston, Mass.; H. A. Wurtz, N. N. Potter, Pittsburgh.

THE SHERWIN-WILLIAMS COMPANY, NEWARK, N. J.—Signs. Representatives: E. M. Williams, E. M. Richardson, W. B. Albright.

DEWITT SAND BOX COMPANY, TROY, N. Y.—Dewitt sand box. Representative: Mr. Dewitt.

WHEEL TRUING BRAKE SHOE COMPANY, DETROIT, MICH.—Brake shoes. Representative: J. F. Griffith, president.

GENERAL EXHIBIT NOTES.

THE STANDARD POLE AND TIE COMPANY, New York, was represented by Mr. E. G. Chamberlin and distributed souvenir pen-holders, and showed its octagonal poles, railroad ties and cross-arms.

CLING-SURFACE MANUFACTURING COMPANY, Buffalo, was represented by Mr. Chas. F. Chase.

NEW PROCESS RAWHIDE COMPANY, Syracuse, N. Y., had as its representatives Messrs. A. C. Vosburgh and T. G. Meachem.

PROVIDENCE CAR FENDER COMPANY was represented by Messrs. A. G. Woodworth, E. C. Hall, G. E. O. Hollingsworth, G. H. Weston.

THE DEARBORN DRUG AND CHEMICAL COMPANY, Chicago, distributed numerous and interesting souvenirs of its own manufacture, among which were bottles of perfumery to ladies, and pamphlets on its boiler feed-water treatment and lubricating oil.

THE OHIO BRASS COMPANY, Mansfield, Ohio, distributed miniature gongs as souvenirs.

STANDARD UNDERGROUND CABLE COMPANY, New York, was represented by Manager C. J. Marsh, eastern and northeastern division; Manager T. E. Hughes, southeastern sales department; Manager A. B. Sauman, northeastern sales department; Manager G. L. Wiley, eastern sales department, and others. Samples of wires and cables of this company's manufacture were exhibited at the New York office, 56 Liberty street, and included all its forms of underground, aerial and submarine cables and insulated wires.

DARLINGTON ELECTRIC FOUNTAIN AND SUPPLY COMPANY, Philadelphia, was represented by F. W. Darlington, president.

BRIDGEPORT BRASS COMPANY, New York, was represented by Wylie Brown, W. F. Malloy and H. G. Madden. The company had on exhibition the Phono-Electric wire and railroad specialties which it manufactures.

H. M. SHAW & COMPANY, New York, was represented by H. M. Shaw and C. J. Harrington. This company manufactures a line of overhead equipments.

ARMSPEAR MANUFACTURING COMPANY, New York, manufacturer of signal lamps and car lanterns, was represented by several of the staff, including C. E. Nicol.

THE NEW HAVEN CAR REGISTER COMPANY, New Haven, Ct., distributed one of the most expensive souvenirs of the convention in the form of a handsomely mounted thermometer.

W. R. OSTRANDER & COMPANY, New York, well known as dealer in electrical supplies, was represented by M. P. Fletcher.

UNDER-FEED STOKER COMPANY, Chicago and New York, was represented by John E. Lewis.

OKONITE COMPANY, Limited, New York, was represented by W. L. Candee, H. Durant Cheever, George T. Manson and W. H. Hodgins.

LOUIS B. WHIELDON, Boston, well known in connection with street railway construction and engineering work, was present.

NATIONAL CONDUIT AND CABLE COMPANY, New York, was represented by J. P. McQuaide, H. F. Tate, F. R. Sias, J. B. Honan.

STERLING VARNISH COMPANY, Pittsburgh and Birmingham, England, was represented by S. C. Schenck and H. Lee Bragg. The company distributed a new sample book descriptive of the Sterling varnishes of different kinds.

AMERICAN VITRIFIED CONDUIT COMPANY, New York, distributed as souvenirs miniature samples of its conduit for paperweights.

AMERICAN CAR SEAT COMPANY, Brooklyn, N. Y., distributed as souvenirs a sole leather stamp case.

NORCROSS MANUFACTURING COMPANY, Philadelphia, was represented by A. H. Chase.

AMERICAN ELECTRICAL WORKS, Providence, R. I., was represented by W. J. Watson, manager of the company's New York office, Frank B. Baker, E. R. Heilig.

J. M. ATKINSON & COMPANY, Chicago, western agent for the protected rail-bond and street railway supplies, was represented by Mr. J. M. Atkinson in person, who is widely known in street railway circles.

ARNOLD ELECTRIC POWER STATION COMPANY, Chicago, was represented by W. L. Arnold and B. J. Arnold.

JOHN A. ROEBLING'S SONS COMPANY, of New York and Trenton, N. J., was represented by H. L. Shippy and others of his office. Mr. George C. Bailey, manager of the Chicago office, was present.

STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., was represented by Charles E. Bibber, who has been for many years well known in street railway circles. Also by Samuel T. Dodd and W. B. Jackson.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, had an exhibit which attracted much attention from the street railway delegates. It comprised types of storage batteries most adapted for street railway service, and parts of storage batteries as used in this type. The company was represented by Herbert Lloyd, Chas. Blizard and others from Philadelphia, New York and Chicago. Joseph E. Lockwood, the Detroit manager, was also present. Also E. L. Reynolds, J. Lester Woodbridge, M. S. Sharpleigh.

RIDGWAY DYNAMO AND ENGINE COMPANY, of Ridgway, Pa., manufacturer of the McEwen automatic engine and Thompson-Ryan dynamos and motors, was represented by Mr. James L. Kimball, manager of this company's Boston office.

THE ELECTRIC CONTRACT COMPANY, of New York, manufacturer of small portable electric battery hand lamp, had an exhibit of these lamps and was represented by Mr. A. W Vandepoel, treasurer.

THE STANDARD PAINT COMPANY, of New York, had headquarters near the main entrance and was represented by the following: Messrs. Ralph L. Shainwald, J. N. Richards and F. F. Van de Water, of New York; Charles Earnshaw, Boston; Gustav Meyer, Hamburg, Germany, and Edward Rich, Sydney, New South Wales. The company distributed attractive literature and a very artistic leather money case.

THE GARTON-DANIELS COMPANY, manufacturer of lightning arresters and telephone apparatus, was represented by the secretary, J. V. S. Titus, president, and Messrs. Morris, Ewing and Sanville, of the New York office.

INTERNATIONAL SPECIALTY COMPANY, Chicago, manufacturer of telephone apparatus and electrical specialties, was represented by Mr. W. B. McCurdy, manager of the New York office.

MR. STEPHEN L. COLES, manager of the technical department of the Shaughnessy Agency, New York, was a visitor.

THE PIXLEY CONDUIT COMPANY, Chicago, was represented by General Manager O. C. Pixley.

STUART-HOWLAND COMPANY, Boston, dealer in street railway supplies and especially overhead equipments, had an attractive exhibition, and was represented by Mr. Herbert W. Smith, assistant manager of the railway department, and others.

THE McROY CLAY WORKS, Brazil, Ind., manufacturer of McRoy conduits, was represented by Mr. J. T. McRoy, president, and Mr. E. F. Kirkpatrick, manager of the Chicago office.

AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., had headquarters in the main corridor. This company had an artistically lighted booth showing "Circular Loom," and distributed literature illustrating its adaptability for street railway service. The company was represented by Mr. H. B. Kirkland, general sales manager; Mr. John G. Green, western manager; Mr. R. B. Cory, agent for the metropolitan district, and Mr. J. L. Kirkland, of the New York office.

ROCHESTER CAR-WHEEL WORKS, Rochester, N. Y., distributed a souvenir of an aluminum pen-knife with four blades, with an inscription of the compliments of the company engraved on the handle.

BAY STATE ELECTRIC HEAT AND LIGHT COMPANY AND THE BERNSTEIN ELECTRIC MANU-

FACTURING COMPANY, Boston, had a joint exhibit. One of the interesting features was a model of the interior of a car with its electric car heater in operation. It also showed some of its low watt reflector lamps for street railway use, and electric fan heaters. The companies were represented by Messrs. E. S. Gardner, superintendent; General B. F. Peach, treasurer, and H. W. Gardner.

ROBINS CONVEYING BELT COMPANY, New York, had a very interesting model of its belt-conveying system. The model was complete in every detail, and was in operation during the entire time of the convention. It showed the system of conveying coal, grain, etc., by means of belts.

STUART-HOWLAND COMPANY, Boston, Mass., showed a complete line of its electrical supplies and apparatus. One of the unique points of the exhibit was that the railing surrounding its booth was composed entirely of street railway cross-arms and brackets, giving it a picturesque appearance. Its handsome souvenir, representing a bear, in bronze metal and intended for a paperweight, was sought after.

UNITED STATES PROJECTILE COMPANY, Brooklyn, displayed its different sizes and styles of pressed steel pinions. The pinion manufactured by this company is made from highly carbonized steel and wrought into shape under heavy pressure, instead of being cut, as is usually done. The company offered as a souvenir a 250-pound projectile to any one who desired to take it away.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., manufacturer of Keystone measuring instruments, had an exhibition adjoining that of the Morris Electric Company. A complete line of switchboard and portable instruments was shown, particularly those adapted for street railway service. The company was represented by Mr. J. Franklin Stevens.

STANDARD VARNISH WORKS, New York and Chicago, distributed one of the prettiest and most sought after souvenirs of the exhibition. It was a watch chain pendant, and was given by Messrs. J. C. Dolph and E. L. Phillips.

SALES ORGANIZATION OF BULLOCK AND WAGNER COMPANIES, Cincinnati and St. Louis, was represented by F. G. Bolles. Mr. Bolles's messengers distributed one of the popular souvenirs of the meeting.

WESTON ELECTRICAL INSTRUMENT COMPANY, Waverly Park, N. J., represented by J. P. Brown, manager of the New York office. This company had an exhibition showing the various types of Weston instruments.

EUGENE MUNSELL & COMPANY, Chicago, manufacturer and dealer in mica specially adapted for electrical service, was represented by Chas. E. Coleman, manager of the Chicago office.

STAR BRASS WORKS, Kalamazoo, Mich., was represented by F. P. Crockett.

DRIVER-HARRIS WIRE COMPANY, Newark, N. J., was represented by Wilbur B. Driver.

SAFETY INSULATED WIRE AND CABLE COMPANY, New York, was represented by A. P. Eckert.

FALK COMPANY, Milwaukee, was represented by Otto H. Falk and E. A. Wurster.

SYRACUSE ELECTRIC COMPANY, of Syracuse, was represented by Henry G. Issertel.

SAWYER-MAN ELECTRIC COMPANY, manufacturer of incandescent lamps, was represented by C. S. Jennings.

DAYTON ELECTRICAL MANUFACTURING COMPANY, Dayton, Ohio, was represented by Joseph Leidenger.

MICHIGAN ELECTRIC COMPANY, Detroit, Mich., was represented by Joseph E. Lockwood. This company has been constructing several interurban electric railways throughout Michigan and Ohio.

EUGENE F. PHILLIPS ELECTRICAL WORKS, Montreal, Canada, was represented by George H. Olney.

WESTERN ELECTRIC COMPANY, New York, was represented by H. C. Owen, M. A. Oberlander and others from New York. Others were present from the Chicago, Philadelphia and St. Louis branches.

PIERCE, RICHARDSON & NEILER, Chicago, was represented by R. H. Pierce.

ROSSITER, MACGOVERN & COMPANY, of New York, was represented by its president, Mr. Clinton L. Rossiter, and its vice-president, Mr. Frank MacGovern. Both Mr. MacGovern and Mr. Rossiter possess a very wide acquaintance in electric railway circles.

CHICAGO INSULATED WIRE COMPANY, Chicago, was represented by Wm. M. Smith.

WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, was represented by Charles Scudder, Jr. This company is a large distributing agent for the West and South for street railway supplies.

J. H. STEDMAN, Rochester, N. Y., who has been in attendance at nearly all street railway conventions, was present.

NATIONAL BATTERY COMPANY, Buffalo, N. Y., was represented by E. A. Spring. This company has recently placed on the market a new storage battery.

PROVIDENCE ENGINEERING WORKS, Providence, R. I., was represented by W. G. Bain.

HENRY R. WORTHINGTON, New York, was represented by J. G. Broaddus.

CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., was represented by F. M. Hawkins, manager of the New York office.

ERIE EXPLORATION COMPANY, New York, was represented by J. P. Erie and M. C. Dougherty.

SIMPLEX ELECTRIC COMPANY, Boston, was represented by J. H. Mason.

HUGO REISINGER, New York, importer of carbons for electric light purposes, was represented by A. T. Webb.

ONE OF THE MOST INTERESTING appliances that was shown at the Madison Square Garden exhibit was the hydraulic rail-punching and bonding apparatus intended for use on the third-rail system of the Manhattan Elevated Railroad, in New York, which was exhibited by the Mayer & Englund Company, New York and Philadelphia. On the Manhattan system, the third or conductor rail consists of a T-shaped section of metal specially compounded to ensure high conductivity. This steel is rather soft and exhibits an exceedingly high conducting power. The bonds consist of short solid drop-forged copper links, six being used at each joint. Of these, two are placed in the web of the rail and two on each side of the foot. The hydraulic machine referred to consists of a punch which punches a hole about seven-eighths inch in diameter through either the web or foot, making a clean, sharp, round hole, somewhat tapered. In this hole the bond is immediately placed before the steel has time to oxidize, and is pressed into place by a hydraulic press giving a pressure of 35 tons, which is sufficient to swage the head of the bond firmly and solidly into the rail. The apparatus resembles a pair of hydraulic jacks, with appropriate punches and jaws. In constructing the conductor rail it is led up in lengths of sixty feet, these being connected together by the solid bonds described until a section 480 feet long is assembled. These 480-foot sections are connected by sliding fish-plates and long flexible bonds, permitting a play of three inches, which is sufficient to take up any expansion and contraction that will be met with in service. The Mayer & Englund Company also exhibited a large line of street railway appliances and materials, including some very interesting telephone devices for communication between cars on the line and a dispatcher's office or superintendent's headquarters.

IN THE SOUTHEASTERN CORNER of the gallery was located the fine exhibit of the Morris Electric Company. Here was shown a large variety of electric railway apparatus, one of the most interesting features being a fine display of steel cross-suspension brackets and centre poles. An interesting arc headlight for electric cars was also exhibited. In this headlight an enclosed arc light is used, the resistance necessary being included in the hood of the lamp, or, if desired, the lamp may be connected in series with the heating appliances on the car. It has been found necessary in high-speed interurban lines, especially when running through dark country, to have a powerful headlight illuminating the track thoroughly for a considerable distance. It is believed that this want is supplied by the headlight mentioned. Cold-welded rail-bonds

of many patterns were also shown in this exhibit, as well as apparatus for making cold-welded joints in wires or other conductors.

PHŒNIX GLASS COMPANY, NEW YORK AND PITTSBURGH, was represented by A. H. Patterson, vice-president and general manager, and E. H. Peck, general sales agent. The beautiful decorative work in globes and shades of the Phœnix company has won it many friends among the street railway companies all over the world.

THE DISTRIBUTION OF COPIES OF THE ELECTRICAL REVIEW Thursday afternoon containing a report of Wednesday's convention proceedings, the first complete list of exhibitors, many notes relating to the exhibition and names of delegates and visitors caused universal commendation. The demand soon exhausted the supply and several subsequent editions Thursday evening and during Friday were distributed. The electric railway men seemed to appreciate the advantage of a weekly publication that gave them the news of the convention so promptly.

MR. W. R. BRIXEY represented his Kerite Company, with headquarters at the Murray Hill Hotel.

MR. CHAS. E. DUSTIN inspected the exhibition with a party of friends.

THE STERLING-MEAKER COMPANY tendered an elaborate luncheon to several of its friends at its office building, 141 East Twenty-fifth street. This was a convenient point for the delegates to the convention and it proved to be a very popular event. Messrs. Carson, Stowe and Ackley, of the company, did the honors of the occasion.

LIEUTENANT F. W. TOPPAN, secretary and treasurer of the Bay State Traction Company, New York, attended the convention and made many new friends among the electric railway visitors. This company is planning a number of installations to be made during the fall season.

THE PITTSBURGH REDUCTION COMPANY presented a number of its friends with aluminum pencil holders with pencil enclosed.

THE ST. LOUIS CAR WHEEL COMPANY gave a small nickel-plated model of a car wheel paperweight as a souvenir.

STREET RAILWAYS: A REVIEW OF THE PAST AND A FORECAST OF THE FUTURE—I.*

BY ROBERT McCULLOCH.

Gentlemen—Not until the latter part of the sixth decade of the nineteenth century did the failure of the rumbling omnibus to meet the requirements and demands for facilities for commercial and social transportation in the cities begin to force itself into public consideration and generate enquiry as to methods of betterment. The cities were spreading in their development beyond the limits of pedestrianism to those whose income justified the expenditure of the cost of the morning and evening ride, and as the distances became greater, the difficulties of existing efforts at accommodation increased. As the income of the merchant and manufacturer increased, so also grew the desire to separate the residence from the shop, and the suburban home followed. Then the time consumed in the journey at the two ends of the business day became a consideration, and next the discomfort of the long ride over streets so poorly paved that they were only, in many instances, badly kept roads. The outgrowth of this casting about for a betterment was the street railway, and almost without exception the original railways were the successors of, and a transformation from, the bus line. The rails were laid in a fashion little akin to the present style of construction. The "bob-tail" car was scarcely better in its accommodation facilities than its predecessor, but its speed was greater and its frequency of service much increased, and its extension beyond the former limits of the stage still increased the opportunity and desirability for border habitations. The same spirit which would allow Davy Crockett to be happy and contented only on the extreme borders of civilization is ever and always making new and extended limits to our cities.

These adventurous pioneers contributed a patronage which encouraged the new enterprise. Rails were laid on all the stage routes. The bus was housed forever, to the regret of the man who had sat so long on its boot and who was so cheerfully greeted by its daily patrons, to all of whom he had grown to be a necessity in the daily routine of life. He took his place on the little platform on the front end of the car, and in the changes that have followed so rapidly in the development of street railway conditions, no man has been his equal as an expert driver or motorman or gripman, and in no hands has the safety of his passengers been so well considered.

Immediately following the installation of the first railways came the war, which attracted the attention, the energy and the enterprise of the whole land. There was no thought then of else than methods and schemes of human destruction. The exciting and alluring and enticing pastime of war possessed the people of the entire land. No hero was so great as he who had stood in the midst of the greatest carnage, and no heritage is so prized as that left by him who unflinchingly met an hundred times his gallant and determined foe. When sheer exhaustion brought peace at last, there had been engendered a vigor and enterprise which perhaps would never have known existence but for the rugged experiences of four years of devotion and courage and manhood never equaled in the history of the world.

This vigor and enterprise found abundant opportunity. The good soldier became the useful citizen, and the street railway, claiming its share of attention, began to contribute its part toward urban development, which development has been made possible only through continued progress of methods and appliances and their application by men as tireless as the sun. Rails weighing twenty-five pounds to the yard were considered ample in their strength and stiffness, and they were rolled in lengths little more than twenty feet. These were spiked to wooden stringers which were held in gauge and alignment by being notched into cross-ties, in which notches they were secured by dovetailed keys. Cars were constructed with special view to lightness in weight, every piece of wood and iron being chambered and worked down to the limit of prudent requirement for strength. Wheels were made of a weight as light as 140 pounds, 180 being a heavy wheel. With few exceptions, roads were originally equipped with the "bob-tail" car, the length of the body being ten or twelve feet, the front end enclosed with a circular dash, and a step on the rear, the passenger opening and closing the door as he passed through it. A fare box on the right of the front door was expected to have the respectful attention and consideration of every passenger, even though, in his anxiety for transportation, he could find a lodgment for only one foot on the rear step, and holding himself in that position by an outstretched arm to a door jamb, with his other hand he passed up his nickel or other money, the change was made, the nickel deposited and the balance returned by various reaches and through several hands. A great improvement consisted in the introduction of a mechanism by which the driver opened and closed the rear door, either by a rod and levers or an endless cord, and next followed a chute having places of deposit at each window post and on the outside of the rear end. The nickel was dropped into this receptacle, the chute having an inclination to the front and ending in either side of the fare box, and thus the fare went up without the intervention of the fellow

* A paper read before the American Street Railway Association October 9, 1901.

passenger. The stove was added in latitudes where the severity of the winter made it necessary, and then the little open car made its appearance during the summer months. This completed the luxury of metropolitan transportation and the street railway was becoming a recognized institution in the process of city development. The motive power of this vehicle was either a single horse or a pair of little fleet-footed mules, with a hill horse at the heavy grades.

The driver was necessarily a man of much capacity, endurance and versatility. He must be an expert in the handling of his horses and in controlling the car through the brake; he must watch in front that he did not run into other vehicles or over pedestrians; he must scan the side streets for the approach of intending passengers; he must closely observe in rear that he might keep track of the passengers who had and who had not paid their fare, that he might always observe a signal to stop, and that the rear step might not be occupied by those who did not intend to pay the required fee for the privilege of a ride; he must make change as desired; he must answer questions and give desired information; he must open and close the rear door; he must, in winter, take care of the fire in the little stove, and at night care for and adjust his lamps; and with all these duties he must stand exposed to the splashing of the mud, the beating of the rain and snow, with his lines in one hand and the other hand constantly on the brake. This work he performed during twelve to fourteen hours on his short day and sixteen to eighteen hours on the long one, and the long and short alternated.

The passenger, we would say to-day, was such through sheer necessity. If he lived five miles away he was an hour from his work, provided there were no mishaps or delays. If the car jumped the track he got out and lifted it on again. If the horse stopped on the up-grades to get his wind or by reason of the obstruction of snow or mud, the passenger "put his shoulder to the wheel" and helped to make the start. He dropped his nickel in the slot, he passed up that of his neighbor, and, with the driver, he frowned on the man who ignored the fare box, and he seldom burnt the midnight oil or wasted his postage stamps in writing and sending letters of complaint. Appliances for the clearing away of snow and ice were crude, entailing ceaseless labor and watchfulness throughout the winter, and the heat of the summer brought equal burden in the care of the faithful animals whose even gait must be maintained notwithstanding the relentless soaring of the thermometer.

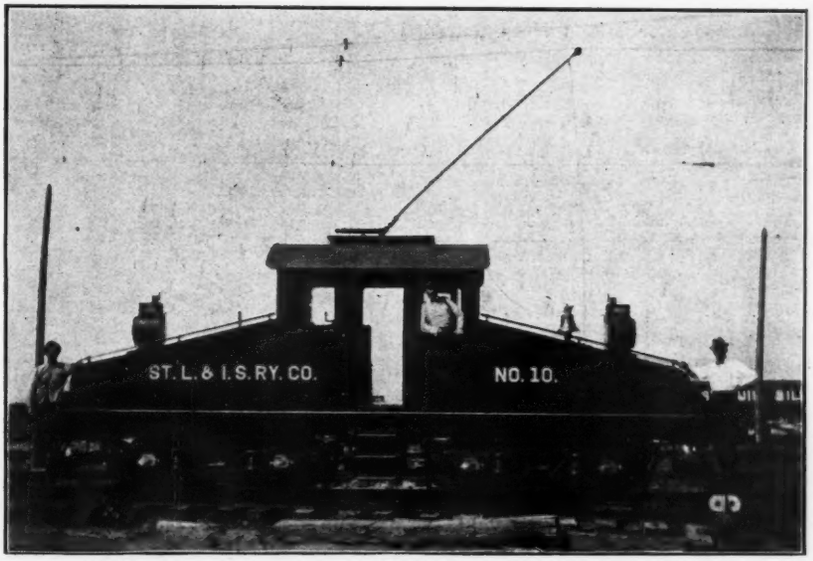
But the "bob-tail"car had only a short-lived existence. It was replaced by a larger vehicle, drawn by two horses and manned by a conductor as well as a driver. In some instances this replacement was made in recognition of the necessity for better provision for an increasing patronage, and in others the angry protest of passengers against the performance of the duties of the conductor drove the last of the "bob-tails" from the street. In the meantime the weight of the rail had been increased and tracks as well as cars were improved. Then came the girder rail, and about the same time the American Street Railway Association had its birth. This brought an era of fellowship and intercommunication among street railway men that had not previously existed. The method of treating colic in horses was no longer held as a trade secret, and the free interchange of experiences in the solution of common perplexities has contributed greatly to the rapid and wonderful developments which can only astound us when we look but a few years backward.

The demand for more extended and more rapid transportation by the man who insisted on living on the extreme border, as well as the driving of the tenement house from the heart of the city by the necessity of occupying this space for manufacturing and warehouse and office purposes, brought into use the cable, but its great cost and its lack of flexibility prohibited its adoption except under favored conditions.

Then, just as some higher and greater power, through human agency, had given us, only when there became extreme necessity for it, steam, and the telegraph, and the reaper and the thrasher, and the telephone, so there came the revelations that enabled the application of electricity to purposes of power for transportation.

Electric Freight Locomotives.

The illustration shows an electric locomotive which has recently been put in service for the handling of coal by the St. Louis, Belleville & Suburban Railway Company, of Belleville, Ill. At present one locomotive is being operated and two are being built, the capacity of each being 20 loaded cars and the weight 50 tons. Its equipment consists of four General Electric motors, of 125 horse-power each. This company has the following lines in operation: St. Louis & Belleville Electric Railway Company and St. Louis, Belleville & Suburban Railway Company, which are both double-track roads between East St. Louis and Belleville, a distance of 14 miles; the Collinsville, Caseyville & East St. Louis Electric Railway, operating between Edgemont, Ill., and Collinsville, seven and one-half miles; the Mississippi Valley Transit Company, operating between East St. Louis and Edwardsville, Ill., *via* Collinsville, 23 miles, and St. Louis, O'Fallon & Lebanon Railway, which is now under construction from Lebanon through O'Fallon, connecting at Edwardsville, a distance of about 15 miles. The lines, with the exception of the St. Louis, Belleville & Suburban Railway, are all standard gauge, 65-pound, T-rail, strictly steam railroad construction throughout. The company expects to operate its electric locomotives on the line of the Mississippi Valley Transit Company, Collinsville, Caseyville & East St. Louis Railway, St. Louis, O'Fallon & Lebanon Railway, St. Louis & Belleville Electric Railway, as well as the Winstanley Park Railroad Company.



An Electric Freight Locomotive.

Scottish Automobile Trials.

The following account of these trials is taken from the London *Electrical Engineer*. It must be exceedingly gratifying to the British public to learn that one result of the automobile trials which took place in and around Glasgow last week, is to show that the English-made car can at least hold its own against the foreign machine in point of reliability. We may say that to this object it was that the contest was mainly directed, the question of speed being quite a secondary consideration. Although the ultimate object of the trials was to promote the British motor-car industry and to regain for it that prestige which it enjoyed in years gone by, the entry list showed that the committee had considered it of primary importance that the public should be made aware of the capabilities of the motor vehicle in its most modern development, without regard to nationality. About a third of the competing cars were of French and two of American make. Comparing generally the cars with those in last year's 1,000-mile trial, a pronounced improvement is to be noticed in safety, speed and hill-climbing capabilities; but this year's trials were much more severe. No repairs were allowed, and the cars obtaining full marks have accomplished over 500 miles, running up hill and down dale, showing reliability in a marked degree. The last day of the trials was the most severe of all, the course being 115¼ miles through a mountainous district by Loch Lomond. Out of the 34 cars which started 30 were driven by petroleum, three by steam and one by electricity; 18 were of British manufacture, 11 French, three American and two German. Seven belonged to private owners and 27 were entered by manufacturers or agents. Among the British cars the Motor Manufacturing Company is said to have obtained the best results. Three cars ran steadily every day, almost without stopping, and earned an aggregate of 4,488 marks out of a possible 4,500. We trust that the excellent results obtained by the English-made cars in the latest international contest will stimulate British manufacturers to yet greater exertions in the effort to get beyond the reach of foreign competition.

A practical test of using telegraph wires for telegraph and telephone purposes at the same time is being made upon the Atchison, Topeka & Santa Fe Railway. A line for experimental purposes, two miles in length, has been equipped under the supervision of Mr. C. J. Sholes, superintendent of telegraph. This line is between Leavenworth and South Leavenworth, Kan. At various points on the Santa Fe system test lines will be put in place. The object is to determine the practicability and cost of the invention in actual service.

Power Transmission by Electricity.

The application of electric motors in manufacturing plants has become so general within the past few years as to demand the attention of power users in all lines of industry.

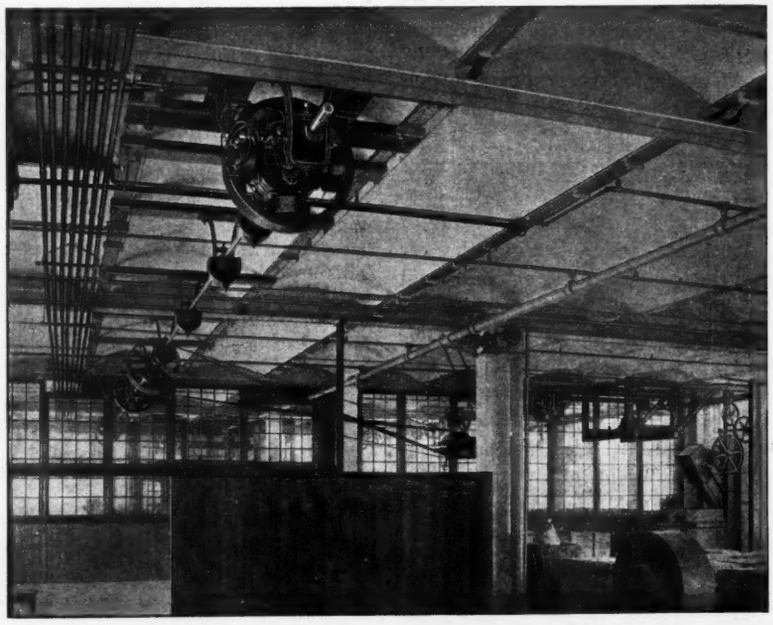


FIG. 1.—THREE ELECTRIC MOTORS ERECTED ON CEILING, OPERATING DIRECTLY ON LINE SHAFTS.

The saving in power and cost of operation is one of the most important factors in favor of the electric motor. In nearly all manufacturing establishments a large proportion of the total power generated is consumed in operating the intermediate transmission machinery required in the distribution of the power from the engine room to the producing machinery which is to be run. With the use of electric motors friction of long lines of main shafting and frequently subsidiary shafting is entirely eliminated. From the results of tests in eight large factories in the United States it was shown that the power utilized to drive the machinery of production averaged but 26 per cent of the indicated horse-power developed, while in the case of the Baldwin Locomotive Works the return was only 20 per cent, the balance being consumed in transmission. The amount of help necessary and cost of attendance in electrically operated plants is usually less than where mechanical methods prevail.

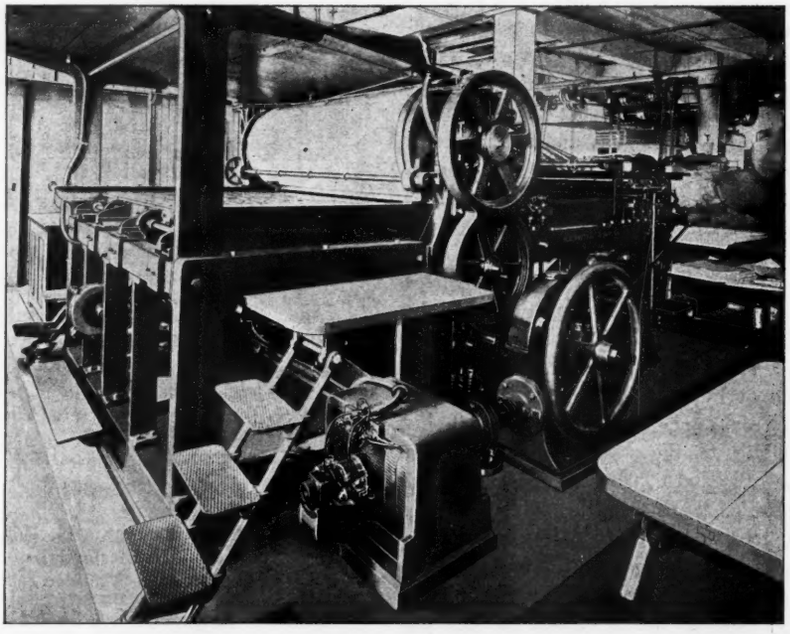


FIG. 2.—ELECTRIC MOTOR AND WORM GEARING APPLIED TO PRINTING-PRESSES.

Electric motor driving places no restric-

tion whatever on the position machines are to occupy and they can be located with regard to economy of production and floor space. It is not necessary that they shall be set up parallel to shafts, or arranged in rows adjacent to each other, as in the case of belted transmissions. This feature is important as it frequently makes possible the more accessible placing of machinery and permits taking advantage of the best light without regard as to how power is to be applied. In the case of the government printing office the ability in the electric drive to arrange machinery irrespective of line shafting made all space equally valuable for all classes of work and enabled the government to add 40 presses which could not have been accommodated under the old system. Mr. Vauclain, of the Baldwin Locomotive Works, states: "Were it not for electric driving, these works would have to cover 40 per cent more floor space than they now do, to maintain the present output." The elimination of heavy overhead shafting, not required in electric driving, also materially lightens the construction of buildings for manufacturing purposes, and enables detached buildings to be reached easily and economically, a result not readily obtained with other methods.

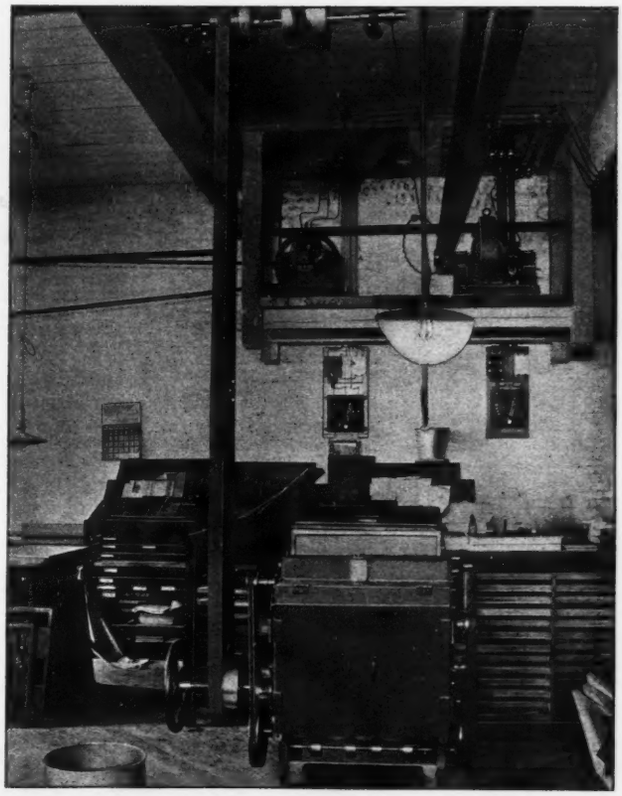


FIG. 3.—ELECTRIC MOTORS DRIVING SHAFTS RUNNING AT RIGHT ANGLES TO EACH OTHER.

The relative cost of equipping a factory with electric motors as against belting and shafting transmission depends very largely upon conditions and circumstances, but would usually be slightly greater for the electric transmission. Since, however, buildings designed for electric driving may be much lighter and cheaper in construction, this saving would largely compensate for the increased difference in the cost of the electric plant. There are many cases, however, where the electric transmission is less in first cost than any other system. It is stated that the depreciation on the electric installation can readily be made less than on shafting and belting, and the cost of maintenance less, while the attention required is no greater. In the case of the United States Government printing office the benefits derived from the use of electric power during the last five years have equaled the cost of and maintained the entire equipment, while the actual saving in coal and gas has been paying 10 per cent on the investment after making an allowance of 6.6 per cent for insurance, taxes and interest. Wherever electric motors have displaced small steam engines, large savings have resulted.

Belting and shafting transmissions obstruct both light and air, while rapidly running belts overhead are dangerous. The dripping of oil and grease from shaft hangers is very objectionable in all factories, and the constant agitation of dust and dirt caused by moving belts in many cases greatly injures the manufactured product. The improvement in the conditions of light and air in all electrically driven factories materially improves the health of employés. There is also less danger to bodily injury in electrically driven plants on account of the freedom from rapidly moving belts.

Accidents to machinery in electrically driven plants are usually local in their effect, simply stopping one or a few machines, whereas the breaking of a belt or similar minor casualty in belt driving may require stopping an entire plant, or a large part of the same. In large establishments, this matter of frequent shutdowns to repair belts and shafting amounts to considerable each year in wages and loss of production and the general effect is demoralizing.

With regard to the decreased cost of production, on account of the improved conditions and economies effected in the saving of floor space and operating expenses realized by the introduction of electric driving at the Baldwin Locomotive Works, Mr. Vauclain states: "If we should abandon electric driving our manufactured product would cost us from 20 per cent to 25 per cent more for labor."

Various methods have been devised for applying and connecting motors to nearly all classes of service. No general plan can be adopted for every case, as individual conditions govern the application best suited. Three general plans, however, are being used successfully and they may be classed as follows:

In the practice of directly connecting the motor it becomes an integral part of the driven mechanism and is mounted directly on the shaft which it is intended to operate. An example of this is illustrated in Fig. 1, in which case three large motors are erected on the ceiling, through the armatures of which the line shafts pass without the use of couplings or connections of any kind. Experience has proven direct connection to be one of the most economical and effective methods of electrical application. Motors may be in like manner erected on the shafts of the individual machines.

The method of spur or worm gearing becomes applicable where large reductions in speed are desired, and an example is shown in Fig. 2, where motors are geared through worm gears directly to each printing-press. This system of individual motor driving possesses many advantages over other systems for many purposes, and is very economical.

The method of belting motors to groups of machinery is applicable where moderate speed reduction is sufficient. The use of the belt in this case is sometimes advantageous and there are also classes of service where it relieves the shock of sudden strain, such as in punching presses, heavy cutters, etc. All of the above systems have their advantages under varying circumstances. Motors operating groups of machines are illustrated in Fig. 3, which is an example of two shafts running at right angles to each other driven from motors located at one point. The Quaker City Electric Company, of Philadelphia, Pa., is manufacturing motors of several types, which are peculiarly adapted to different methods of application.

Pan-American Awards.

Gold medals have been awarded as follows, in the department of electricity, at the Pan-American Exposition in Buffalo:

American Steel and Wire Co., Chicago, New York city; electric wires and cables.

Belding Bros., New York city; electrical silk.

Delany, Patrick B., South Orange, N. J., apparatus for rapid telegraphy.

General Electric Co., Schenectady, N. Y.; machinery and apparatus for generating and using electricity.

General Electric Co., Schenectady, N. Y.; electric lighting apparatus.

General Electric Co., Schenectady, N. Y.; electrical measuring instruments.

Holophane Glass Co., New York city; Holophane glass globes.

Kellogg Switchboard and Supply Co., Chicago; telephone systems and apparatus.

National Carbon Co., Cleveland, Ohio; carbon products.

Niagara Falls Power Co., Niagara Falls, N. Y.; electric transmission plant, as illustrated by model.

Pittsburgh Reduction Co., Niagara Falls, N. Y.; electrical conductors of aluminum.

Roebling's Sons & Co., J. A., Trenton, N. J.; wires and cables. (Four gold medals in classes 4, 10, 11, 13.)

Safety Insurance Wire and Cable Co., The, New York city; electric wires and cables.

Standard Underground Cable Co., Pittsburgh, Pa.; electric wires and cables.

Stanley Electric Manufacturing Co., Pittsfield, Mass.; high-tension, alternating-current apparatus.

Stanley Instrument Co., Great Barrington, Mass.; electric wattmeters.

Stromberg-Carlson Telephone Manufacturing Company, Chicago; telephone exhibits and service.

In other departments some of the gold medals awarded were to the following:

Automobile Co. of America, New York city; gasmobile.

Baldwin Locomotive Works, Philadelphia, Pa.; steam and electric locomotives.

J. G. Brill Co., Philadelphia, Pa.; cars and trucks for electric roads.

Consolidated Railway Electric Lighting and Equipment Co., New York city; car light by electric power from the axle.

De Dion-Bouton Motorette Co.; bicycles and quadricycles.

Electric Vehicle Company, New York city; bicycles (variety and completeness).

Electrical Vehicle Company, New York city; electric automobiles.

General Electric Co., Schenectady, N. Y.; electric traction apparatus and system.

Gould Coupler Co., Depew, N. Y.; car light by electric power from axle.

John A. Roebling's Sons Co., Trenton, N. J.; general exhibit in transportation.

American Bridge Co., New York; steel structural material and steel buildings.

E. S. Ritchie & Sons, Brookline, Mass.; ships' compasses.

Lunkenheimer Co., Cincinnati, Ohio; valves, lubricators and engine fittings.

Becker-Brainard Milling Machine Co., Hyde Park, Mass.; vertical milling machine.

Brown & Sharpe Mfg. Co., Providence, R. I.; automatic gear-cutting machine.

Carborundum Co., Niagara Falls, N. Y.; carborundum.

Dodge Mfg. Co., Mishawaka, Ind.; rope transmission.

Ferracute Machine Co., Bridgeton, N. J.; stamping machinery.

Jenkins Bros., New York; steam and water valves.

Long & Allstatter Co., Hamilton, Ohio; power punching and shearing machines.

Marinette Iron Works Mfg. Co., Marinette, Wis.; Wallrath gas engine.

August Mietz, New York; kerosene engines.

Morris Twist Drill and Machine Co., New Bedford, Mass.; machine tools.

Niles Tool Works, Hamilton, Ohio; boring and turning machines.

Otto Gas Engine Works, Philadelphia; gas engines.

Pratt & Whitney Co., Hartford, Ct.; drills, reamers, cutters and measuring tools.

Robbins Conveying Belt Co., New York; belt conveyor.

Reeves Pulley Co., Columbus, Ind.; variable speed transmission.

Straight Line Engine Co., Syracuse, N. Y.; steam engine.

Chas. A. Schieren & Co., New York; leather belting.

Struthers, Wells & Co., Warren, Pa.; gas engine.

Henry R. Worthington, Brooklyn, N. Y.; jet condenser.

Among others, the following were awarded silver medals:

American Steel and Wire Co., Chicago and New York; cold-drawn shafting.

American Blower Co., Detroit, Mich.; fans and blowers.

American Roller Bearing Co., Boston; roller bearings.

Ball Engine Co., Erie, Pa.; steam engines.

Buffalo Forge Co., Buffalo; punches, shears, forges, etc.

Burt Mfg. Co.; Akron, Ohio; oil-filters.

E. W. Bliss Co., Brooklyn, N. Y.; sheet-metal stamping and drawing machines.

Deane Steam Pump Co., Holyoke, Mass.; condensers and power pumps.

Fitchburg Steam Engine Co., Fitchburg, Mass.; steam engine.

Foos Mfg. Co., Springfield Ohio; gas and gasoline engines.

Green Fuel Economizer Co., Matteawan, N. J.; fuel economizer.

Hazard Mfg. Co., Wilkesbarre, Pa.; wire rope.

L. S. Heald & Son, Barre, Mass.; lathe centre grinder.

Prentiss Tool and Supply Co., New York; general arrangement of exhibit of machine tools.

Pratt & Whitney, Hartford, Ct.; automatic turret lathes, compound boring machine, automatic toolmakers' lathe.

Reeves Pulley Co., Columbus, Ind.; wood-split pulleys.

Wheeler Condenser and Engineering Co., New York; Wheeler-Admiralty condenser with combined air and circulating pump.

Weber Gas Engine Co., Kansas City, Mo.; gas and hoisting engines.

American Vitrified Conduit Co., New York; vitrified clay conduits.

Bernard Co., E. G., Troy, N. Y.; motor-generator sets and accessories.

Bullock Electric Mfg. Co., Cincinnati, Ohio; dynamos and motors.

Camp Co., H. B., Akron, Ohio; vitrified conduits.

Crocker-Wheeler Co., Ampere, N. J.; dynamos and motors.

Cutler-Hammer Mfg. Co., Milwaukee, Wis.; motor starters and controllers.

D. & W. Fuse Co., Providence, R. I.; fuses and fuse fittings.

Edison Mfg. Co., Orange, N. J.; mechanical apparatus for recording and producing sound; also Edison-Lelande battery.

Electric Storage Battery Co., Philadelphia; methods and appliances for the distribution of electric energy; also storage batteries.

Eureka Tempered Copper Co., North East, Pa.; tempered copper and cast copper.

Gould Storage Battery Co., New York; storage battery.

Hydra Double Battery Co., New York; dry battery.

McRoy Clay Works, Brazil, Ind.; vitrified conduits.

Northern Electrical Mfg. Co., Madison, Wis.; direct-current dynamos and motors.

Queen & Co., Philadelphia; self-regulating X-ray tube.

Stanley Electric Mfg. Co., Pittsfield, Mass.; measuring instruments.

Wagner Electric Mfg. Co., St. Louis, Mo.; single-phase motors and transformers.

Baker Motor Vehicle Co., Cleveland, Ohio; electric runabout.

Gold Car Heating Co., New York; car-heating apparatus.

Safety Car Heating and Lighting Co., New York; car-heating apparatus.

Woods Motor Vehicle Co., Chicago; automobiles.

Cassidy & Son Mfg. Co., New York; electric fixtures.

Among others, the following were awarded bronze medals:

American Electric Telephone Co., Chicago; telephone apparatus.

American Engine Co., Bound Brook, N. J.; direct-connected dynamos.

Bossert Electric Construction Co., Utica, N. Y.; switches.

Brown, Harold P., New York; plastic amalgam joints.

Clark Automatic Telephone Switchboard Co., Providence, R. I.; automatic telephone switchboards.

Incandescent Electric Light Manipulator Co., Boston; lamp manipulator and attachments.

Jandus Electric Co., Cleveland, Ohio; enclosed arc lamp.

Jantz & Leist, Cincinnati, Ohio; electroplating dynamos and driving motor.

Keystone Electric Co., Erie, Pa.; direct-current generators.

Morris Electric Co., New York; Morris rail-bonds and hydraulic splicing machines.

National Carbon Co., Cleveland, Ohio; primary cells.

Onondaga Dynamo Co., Syracuse, N. Y.; direct-connected dynamo and electric motor.

Peru Electric Mfg. Co., Peru, Ind.; porcelain devices for electric purposes.

Porter Battery Co., Chicago; storage batteries.

Roche, William, New York; dry cells.

Standard Paint Co., New York; P & B tape, insulating compound, and armature and field-coil varnish.

Submerged Electric Motor Co., Menominee, Wis.; submerged electric motor and propeller.

Toerring Co., C. J.; Philadelphia; arc lamps.

Waitt & Bartlett Mfg. Co., New York; X-ray apparatus.

Wilhelm Telephone Mfg. Co., Buffalo; telephone apparatus.

Garlock Packing Co., Palmyra, N. Y.; Garlock packing.

Keasbey, Robert A., Buffalo; magnesia covering.

Knowles Steam Pump Works, New York; triplex electric pumps.

Monarch Mfg. Co., Waterbury Ct.; safety engine stop valves.

Monarch Fire Appliance Co., New York; "Kilfyre" dry powder extinguisher.

Otto Gas Engine Works, Philadelphia; Otto Railroad water crane.

Replogle Governor Works, Akron, Ohio; water wheel governors.

Skinner Engine Co., Erie, Pa.; steam engine.

Snow Steam Pump Works, Buffalo; steam pumps.

Underfeed Stoker Co. of America, Chicago; stokers.

Among those receiving honorable mention were the following:

Abendroth & Root Mfg. Co., New York; spiral riveted pipe.

American District Steam Co., Lockport, N. Y.; underground system of steam heating from central station.

Cling-Surface Mfg. Co., Buffalo; Cling-Surface belt dressing.

Morris Electric Co., New York; wheel-truing brake shoe.

Palmer Bros., Mianus, Ct.; gasoline engines and launches.

Bogue, C. J., New York; photo-engraving electric lamps.

Cutler-Hammer Mfg. Co., New York; printing-press electric controller.

New England Motor Co., Lowell, Mass.; five-horse-power compound motor.

Tug vs. Cable.

The illustration on this page shows what happened one day recently, when the harbor tugboat James D. Leary got its propeller tangled in an Okonite cable belonging to the Narragansett Electric Light Company, of Providence, R. I., and running from East Greenwich to Pattowannet, R. I. When the tug tackled the cable it was brought up with a round turn, and, after several ineffectual efforts to get away, found itself ignominiously anchored and powerless. The cable was cut and the boat was ordered to dry dock, where the photograph was taken. The attitude of the owner of the tugboat, who also appears in the photograph, is suggestive of a mental question as to whether the tug was too much for the cable, or the cable was too much for the tug. The knot illustrated is unusually complicated, although it is not remarkable for propeller vessels to pick up cables in this way.

A Tugboat Propeller Fouled by Cable.

Under the direction of Dr. H. W. M. Edmonds, of the United States Coast and Geodetic Survey, a magnetic observatory is being constructed at Sitka, Alaska.

Telephone Consolidation.

A consolidation of all the independent telephone companies in eastern Pennsylvania has been effected in that state. It is stated that this will be followed by the merging of all the independent systems of the entire state of Pennsylvania with those of New Jersey, and which will be eventually connected with a proposed system between New York and Boston. The Consolidated Telephone Company of Pennsylvania is the corporate title of the combine. The principal offices are to be in Allentown, Pa. It officers are: President, Robert E. Wright, Allentown; secretary, Dr. T. H. Leidy, Reading; treasurer, C. M. W. Keck, Allentown. The board of directors has not been chosen. The following telephone companies are the ones consolidated: The People's Telephone Company, of Wilkesbarre; Anthracite Telephone Company, of Hazleton; Slate-Belt Telephone Company, of Slatington; Lehigh Telephone Company, of Allentown; Schuylkill Telephone Company, of Schuylkill, and the Lackawanna Telephone and Telegraph lines, of Scranton.

A New Electric Gas Lighter.

The Aladdin electric gas lighter has just been placed on the market by the Aladdin Manufacturing Company, of New York. Wherever gas is used there is a place for such a lighter, which by simply pressing the button ignites the gas.

For gas stoves, gas logs, Welsbach and other mantle burners it is quicker than a match. The mechanism is simple, a dry battery furnishing the spark.

One of these lighters, taken from stock, is said to have ignited the gas 6,409 times before its battery gave out. A new battery was placed in it, and the lighter has been used 3,000 times since and is still working, which shows its practicability.

Electric Gas Lighter.

Nernst Lamps at the Glasgow Exposition.

On September 4 Lord Kelvin performed the ceremony of switching on the Nernst lamp installation, for the first time in Scotland, at the stand of the Electrical Company, Limited, at the Glasgow Exhibition. To witness the proceedings there were present Lady Kelvin, Dr. Bottomley, LL.D., and Mrs. Bottomley, Sir William Preece, Geheimerath E. Rathenau, Mr. Oscar von Miller, Mr. J. Stottner, the general manager of the Electrical Company, Limited, and many other eminent scientists and engineers. The Nernst lamps, which brilliantly illuminate the large stand of the Electrical Company, will be alight every evening until the close of the exhibition.

The contract for the tunnel and portal of the large electric power plant on the Canadian side at Niagara Falls has been awarded by the Canadian Niagara Power Company. The price is said to be over half a million dollars and the work is to be completed by January 1, 1902. The tunnel will be 2,200 feet in length and 19 by 21 feet in diameter. It will be bricked throughout, the same as the tunnel on the American side. At the present time a shaft has been sunk the required depth and the work of excavating the tunnel will be begun immediately by the contractor.

A system of wireless telegraphy has been tested by Lieutenant-Colonel Samuel Reber, U. S. A., which is said to give excellent results. It is also stated that it does not infringe upon Mr. Marconi's patents. This system is now in use between Alcatraz Island and the Presidio, San Francisco.

Plan to Connect Long Island Railroad with Rapid Transit System.

The Board of Rapid Transit Commissioners has received a plan for the connection of the Long Island Railroad system with the new underground railroad of New York. The Long Island Railroad Extension Company, which is a subsidiary concern of the Long Island Railroad, submitted the plan. Mr. W. H. Baldwin, Jr., president of the latter company, appeared before the board and supported the proposition. The application was to secure permission to build a tunnel from Thomson avenue, in the Borough of Queens, to connect at that point with the Long Island Railroad to Thirty-third street and Fourth avenue, and thence to a terminal at Long Acre Square, Manhattan.

At both of these places it is proposed to establish connections between the new tunnel and the rapid transit lines, which would be accomplished by means of subways and staircasing. It was explained to the commissioners that the company was preparing to lay two steel tubular tunnels beneath the East River. Electricity would be the motive power used. It is intended to carry both freight and passengers. Four years would be occupied in the construction of the route according to the plans, and the cost would be about $5,000,000.

Electric Railways in Chattanooga

The Rapid Transit Company, of Chattanooga, Tenn., has recently purchased several pieces of property, including the right of way and road-bed of the steam railroad which ran up Lookout Mountain a few years ago, but has since been discontinued. This is to be rebuilt for electric car service and will be a very interesting road, not only from an engineering point of view but it passes through the battle-field of "the battle above the clouds," and stone breastworks erected by the Confederate forces can be seen along the route quite frequently. This line will connect with the electric line already in operation at the top of the mountain.

The company has also purchased the two incline roads which are in operation from the foot to the summit at present. A line will be built from Chattanooga to connect with the incline to handle the traffic until the new electric road is completed.

This company also operates lines from Chattanooga to the National Cemetery and to the Chickamauga National Park, the site of the Chickamauga battle, besides several interurban lines to other places.

Elliott Perry Gleason.

Mr. Elliott P. Gleason, the president and founder of the E. P. Gleason Manufacturing Company, died, after a short illness, at his home in Brooklyn, on September 26, 1901, in his eighty-first year. He was born in Westmoreland, N. H., of sturdy New England stock, on June 27, 1821. At the age of fifteen he was apprenticed to a tinsmith, but ill health compelled him to give up the work. He went to Attleboro, Mass., where he worked at the jewelry business for a little while. From there he went to Providence, R. I., accepting a clerkship in a general store. His fertile brain evolved—in Providence—among early inventions, a process of letter-

MR. ELLIOTT P. GLEASON.

ing on glass, a gas tip separate from the pillar, a shade holder with flexible arms to yield to the expansion and contraction of the glass; before 1860 holders usually had rigid cast arms or were provided with a ring.

In 1854 he formed a partnership, under the firm name of Mooney & Gleason, for the manufacture of gas burners and supplies for the then growing industry of gas illumination. The firm prospered, but in 1867 Mr. Gleason, finding Providence too small for him, came to New York. In 1871 he incorporated the E. P. Gleason Manufacturing Company, and branched out into the general fittings and appliances used by gas-fixture makers.

When electric illumination was developing, Mr. Gleason's company was one of the first to make fittings and appliances solely adapted for electric lighting; among Mr. Gleason's electrical inventions are globe holders, insulating joints and many standard fittings. In addition to those previously mentioned, Mr. Gleason had many other large manufacturing interests in different lines of business.

His life well typifies the restless, acute, indefatigable, successful New England inventor, whose genius lies at the base of so much that is finest and best in American achievement in the arts and sciences. A number of nephews who were associated with Mr. Gleason in business will conduct the various branches as heretofore.

Chicago Electrical Association Programme.

The following is the programme for the fall and winter of the Chicago Electrical Association:

October 4—"Telephone Protectors," by Samuel G. McMeen, Central Union Telephone Company.

October 18—"The Induction Motor," illustrated by stereopticon, by Wm. Hand Browne, Jr., assistant professor of electrical engineering University of Illinois.

November 1—"The Storage Battery in Telephone Work," by J. G. Wray, electrical engineer Chicago Telephone Company.

December 6—"Demonstration of High-Frequency Effects," Arthur Vaughn Abbott, electrical engineer. (Ladies' night.) This meeting will be held in the Auditorium of Lewis Institute, West Madison and Robey streets.

January 3, 1902—"Proposed New Rating of Incandescent Lamps," by John D. Nies, instructor in electrical engineering Lewis Institute.

The following are the officers for 1901: R. F. Schuchardt, president, 139 Adams street; Harold Almert, vice-president, 1706 Dewey Court; W. J. Warder, Jr., secretary, 900 Warren avenue; H. G. Dimick, treasurer, 242 South Jefferson street; C. E. DeCrow, auditor; W. B. Hale, librarian; L. G. Bassett, J. R. Cravath, H. P. Clausen, directors.

Massachusetts Street Railway Association's Annual Convention.

The annual meeting of the Massachusetts Street Railway Association was held at Young's Hotel, Boston, September 11, 1901, and the following officers elected: President, Elwin C. Foster, Lynn, Mass.; first vice-president, Edward P. Shaw, Newburyport, Mass.; second vice-president, Francis H. Dewey, Worcester, Mass.; treasurer, Fred H. Smith, Quincy, Mass.; secretary, Charles S. Clark, Boston, Mass. The following gentlemen compose the executive committee, which was elected: Edward P. Shaw, Newburyport, Mass.; John R. Graham, Quincy, Mass.; Elwin C. Foster, Lynn, Mass.; Francis H. Dewey, Worcester, Mass.; H. H. Crapo, New Bedford, Mass.; P. F. Sullivan, Lowell, Mass.; William S. Loomis, Holyoke, Mass.; Robert S. Goff, Fall River, Mass. The following auditing committee was also elected: Horace B. Parker, Newton, Mass.; W. W. Sargent, Fitchburg, Mass.; George W. Cook, Springfield, Mass.

The price of platinum is said to be higher now than ever before, being $36 an ounce.

Current Electrical News

COMMERCIAL NEWS

DOMESTIC AND EXPORT

It is reported that Mr. Charles W. Morse, of New York, has acquired the controlling interest in the Rockland, Thomaston & Camden Street Railway, of Camden, Me.

Lloyds Shipping Agency and the Marconi Company have entered upon an agreement by which the stations of the agency throughout the world are to be equipped with wireless telegraphy apparatus.

The first cable for the telephone line between Brussels and London has been laid, a distance of 250 miles, 56 of which are under water. The cost of the construction of the line will be about £36,000.

The use of electric power in place of steam has been resumed on the Fifth avenue and Bath Beach lines of the Brooklyn Rapid Transit Company. Through trains on these lines will be run across the Brooklyn Bridge.

It is stated that the Winnipeg Street Railway Company and the Ogilvie Mining Company have combined interests in the matter of bringing electric power for the operation of their respective machinery. This power will be brought from a point on the Winnipeg River.

The town council of Mobile, Ala., has granted to the Consolidated Street Railway Companies an extension of their franchises to March 12, 1955, a term of about 12 years more than they previously had to run. The council also granted them the use of a number of streets in the city.

In equipping the Springfield & Xenia Railway, of Springfield, Ohio, it has been decided to use the third-rail system. The third rail is to be put down on the outer edge of the track already laid. The power for the line will be furnished by the Dayton, Springfield & Urbana line.

It is expected that the Cape Breton Electric Company will obtain a franchise from the Grace Bay council permitting it to start work on the construction of an electric railroad through that town. This means that within a short time the industrial centres of Cape Breton will be belted by electric roads.

The People's Railway Company, of Wilmington, Del., has received a charter from the Delaware Secretary of State. This company has a capital of $1,500,000. It is a merger of the Brandywine Springs Railway Company, the Elesmere & Wilmington Railway Company, the Park Railway Company, the Citizens' Electric Railway Company, and the People's Electric Railway Company.

The following street railroads have been consolidated in and about Utica, N. Y.: The Utica Belt Line & Suburban; Utica & Mohawk; Utica & Deerfield; Oneida Street; Herkimer, Mohawk, Ilion & Frankfort Railroads. The name of the consolidated company is the Utica & Mohawk Valley Railway, and its capitalization is $3,000,000. The incorporators have taken all the stock.

Arrangements are now being completed for the location of the offices of the New Orleans & Carrollton Railroad, Light and Power Company in the Edison Electric Building in New Orleans, La. Mr. J. K. Newman is the president of the consolidated concern. The capital stock of the new company is $7,500,000 divided into 75,000 shares of $100 each, 50,000 shares of which are preferred stock.

The Birmingham Railway, Light and Power Company, of Birmingham, Ala., has been granted a franchise to operate lines over additional streets and avenues in that city. Mr. Jemison, president of the company, has stated that it intends to spend $2,500,000 in the improvement of the street railway system there and that about two years' time would be required to complete the work.

Comstock Brothers, Detroit, Mich., have gained possession of the Cincinnati, Georgetown & Portsmouth Railway. This railway will now be changed to standard gauge and equipped with electricity. The road now ends at Georgetown, but it will be extended to Ripley at once, and later on to Portsmouth, Ironton and other points. Mr. A. W. Comstock will succeed Mr. Ralph Peters as president of the road.

All the properties of the Everett-Moore Syndicate are being consolidated into the Lake Shore Electric Railway Company. Announcement has been made that a sleeping car service will be installed between Cleveland and Detroit. The cars will be roomy and comfortable, and will be splendidly heated and lighted throughout. The interior furnishings will be such as to compare favorably with Pullman and Wagner sleepers.

It is stated that it has now been practically settled that the Colorado & Southern Railroad will install electricity as a motive power on all its suburban lines running out of Denver. An expert was sent to Europe to investigate the various electric systems in use in Berlin and other cities during the summer. This expert has returned recently and his report was favorable to the change to electricity and he stated that the change would not involve a cost which the railroad could not sustain. The suburban lines on which this change is to be made are five in number, entering Denver from different directions.

The Consolidated Telephone Companies of Pennsylvania is the title of a company which is to operate under the charter of the Schuylkill Valley Telephone and Telegraph Company, of Reading, which has been organized in Allentown, Pa. Mr. Robert E. Wright has been elected president. The directors will be chosen later. Seven independent telephone lines from Scranton to Philadelphia have been merged. The capital stock is $4,000,000. The companies consolidated are the Lackawanna, of Scranton; People's, of Wilkesbarre; Anthracite, of Hazleton; Slate Belt, of Bangor; Lehigh, of Allentown; Schuylkill Valley, of Reading, and the Inter-State, of Philadelphia.

Investigations which have been made by Mr. J. N. Hill, the eldest son of President J. J. Hill, have convinced President Hill that there is a great saving to be made in operating trains by water power conveyed in the form of electricity. At first the operation of trains by electricity in the Cascade Tunnel, a distance of about two and one-half miles, was contemplated. It is reported that now electric power will be used to operate the portion of the road extending from Leavenworth to Skykomish, a distance of sixty-six miles. It is said that if the electric motors are a success they will be immediately operated from Everett to Wenatchee, a distance of 141 miles, and eventually extended to include the entire mileage of the system.

ELECTRIC RAILWAYS

Trolley cars have begun running between Oneonta and Cooperstown, N. Y.

The work on the Wylam electric line in Pratt City, Ala., is being pushed by a large force of men.

Mr. D. F. Keenan has received the contract to construct the Latrobe Street Railway in Latrobe, Pa.

News comes from Winston, N. C., that the survey of the railway from that place to Wadesboro is soon to begin.

A franchise to construct and maintain an electric railway in Gouverneur, N. Y., has been granted to Mr. Charles McCarty.

The power for the Sandusky & Interurban line in Sandusky, Ohio, will be furnished from the power-house at Bath Beach.

A franchise has been granted to the Kansas City, Parkville & St. Joseph Electric Railway through Buchanan County, Mo.

Contracts have been given out by the Greensburg & Southern Electric Railway for the building of the track to Youngwood, Pa.

The capital stock of the Las Vegas-Hot Springs Electric Railway in New Mexico has been increased from $200,000 to $350,000.

News comes that the work of constructing the trolley line which is to be built between Schenectady and Amsterdam, N. Y., will be begun this fall.

Mr. George J. Hurd has filed an application with the city clerk of Janesville, Wis., to build, operate and maintain an electric line in that city.

Work upon the street railway in St. Albans, Vt., is now being pushed rapidly. There was a slight delay because of the non-arrival of steel rails caused by the steel strike.

A new company, known as the Southern Michigan Traction Company, consisting of Cleveland capitalists, has been organized to build a railway from Grand Rapids, Mich., to Plainwell.

The contract for grading and masonry between Wheaton and Elgin, Ill., for the Elgin branch of the Electric Railway Company, has been granted to Bracy, Howard, Foster & Company, of Chicago, Ill.

A charter has been granted to the Conemaugh Valley Street Railway Company to build a trolley line from Ebensburg to Johnstown, Pa. Mr. Robert H. Murphy is among those interested in the line.

Petitions are being circulated in Bloomington, Ill., for the right of way for an extension of the Bloomington & Normal Street Railway lines to furnish transportation in the southeast part of the city.

The town council of Burrillville, R. I., is considering the matter of granting a franchise to the Columbian Street Railway Company for a line from the Statesville terminus of the Woonsocket system to Pascoag.

The Auburn Interurban Electric Railway Company has filed a certificate of extension of its route from Skaneateles to Marcellus with the Secretary of State of New York. The extension will be mainly over private lands.

The village board of Northport, N. Y., has granted a franchise to the Northport Trac-

tion Company. The Traction company has for its object the building of a trolley road between Northport and the East Northport station.

A charter to build an electric railway from Rushville, Ill., to Hardin, a distance of 130 miles, has been applied for by Messrs. Robert W. Gardner, C. H. Kastel and others. It is estimated that the road will cost about $1,000,000.

Work will be begun at once by the Union Traction Company on an automobile power plant on the line of the Philadelphia & Newtown & New York Railroad to supply power to the new Frankford and Falls of the Schuylkill line in Pennsylvania, which is to be opened shortly.

At a meeting of the board of county commissioners of Wyandotte County, in Kansas City, Kan., a franchise was granted to Mr. William Lacklin to construct and operate an electric railway from Rosedale to the Johnson County line, a distance of something over two miles.

Mr. H. C. Runyon states that a fully equipped trolley line will be in operation between Plainfield and South Plainfield, N. J., before the coming winter is over. As soon as the consent of property owners and a franchise have been granted the building operations will be commenced.

The stockholders of the Worcester Traction Company, which controls the street car lines in Worcester, Mass., have met in Newark, N. J., and taken preliminary steps toward winding up the affairs of the company. A resolution has been adopted which provides for canceling nearly all of the preferred stock.

Mr. William W. Randolph, of New York, who is the consulting engineer for the syndicate which recently secured control of the Wilmington Seacoast Railroad, is in Wilmington, N. C., looking over the field in connection with a scheme for converting the Seacoast Railroad into a trolley line from Wilmington to Wrightsville Beach.

A mortgage has been executed by the Asheville & Weaverville Street Railroad and Power Company, in Asheville, N. C., for $150,000, to the Royal Trust Company, of Chicago. The amount is to be secured in bonds. It is reported that the capitalists who are interested in the electric road enterprise are considering the extension of the road from Asheville to Burnsville.

Those interested in the trolley line from Worcester, Mass., to Providence, R. I., have petitioned for a charter in Massachusetts, granting them the right to build the road from Worcester through the towns of Millbury, Sutton and Douglas to the Rhode Island state line. Messrs. James W. Stockwell and Henry B. Bullard, of Sutton, Mass., are among those interested in the new line.

The Carroll Electric Company, of Fishkill Landing, N. Y., has been consolidated with the Citizens' Street Railway Company. The board of directors will be the present officers of the railway company with the addition of Mr. William Carroll. It is said that the capacity of the electric light concern will be increased by the new organization and about $20,000 spent in improvements.

The Union Railway Company, of New York, has been granted a franchise by the city council for a trolley railroad across Central Bridge from 155th street and Eighth avenue to Jerome and Sedgwick avenues, which is intended to form a connecting link between the Eighth avenue line of the Metropolitan Street Railway, the West Side Elevated Railroad and the Jerome Avenue line of the Union Railway in the Borough of the Bronx.

ELECTRIC LIGHTING

Messrs. White & Coughlin, contractors, are rebuilding the electric light plant at the Glens Springs Sanitarium, New York.

Mr. G. O. Saunders, who has a winter home in Hamlet, N. C., has gone north to buy the machinery for a new electric light plant which is to be put in operation in that place.

Mr. A. A. Atkinson, of the Toledo Traction Company, of Toledo, Ohio, is arranging to furnish light and power to the factories, stores and private dwellings on and near East Broadway.

At a meeting of its directors the Economy Electric Company, of Warren, Ohio, has decided to build an addition three stories high and thirty by eighty feet for the purpose of enlarging its plant.

The Pomeroy-Mandelbaum Syndicate has purchased the Norwalk Gas and Electric Company, of Norwalk, Ohio, which had a capital stock of $125,000 and a bonded indebtedness of $110,000.

The Adams Brothers Company, in Findlay, Ohio, has had ground broken for its electric light plant with which it will illuminate its foundry, factories and boiler plant. It is to be a finely equipped plant.

The bids on contracts for putting in electric plants in Tullahoma, Tenn., have been opened by the electric light and waterworks commissioners. There were twenty-seven in all. The decision of the commissioners has not been made public.

During the time while the washout of the new electric light plant is being repaired in Fredericksburg, Va., arrangements for lighting the city have been made. About six weeks will be required to repair the damage. The cost will be about $3,000.

The contract of the Depere Electric Light and Power Company, which has supplied light for the Green Bay Electric Light Company, in Green Bay, Wis., has been discontinued. All the power of the plant in that city will now be used for local power service.

The property belonging to the Faribault Consolidated Gas and Electric Company, of Faribault, Minn., has been sold at public auction by order of the United States Circuit Court, to Mr. George C. Hollister, a banker of New York, for $25,000. Originally this plant, which was modern and well equipped, cost about $125,000.

A large number of poles are being received by the Electric Light Company, in Jacksonville, Fla. The poles are being erected as rapidly as possible and the public and private houses wired. Good progress is being made on the power-house plant. Under the contract with the city it is to be in operation by January 1, 1902, but this date may be considerably anticipated.

Judge Campbell has made a proposition to furnish the city of Riverside, Cal., with electric power. The minimum amount to be furnished was 200 horse-power for thirty years at a special price per horse-power. At the end of the term the plant, transmission line, etc., was to be turned over to the city at no expense to Riverside and in as good condition as when it was installed.

An application for a corporation to be known as the People's Light and Power Company has been filed in the office of the clerk of Hamilton County, Tenn., by Messrs. Joseph H. Warner, Edwin Warner and others. The purpose of the company is to manufacture electric light and generate electricity for motive power, electrotyping, heating houses, etc. The capital stock is fixed at $200,000.

TELEPHONE AND TELEGRAPH

The Keystone Telephone Company, of Philadelphia, has received a franchise from the council of Ridley Park, Pa.

Good progress is being made upon the work of extending the lines of the Iron Range Telephone Company in Cass Lake, Minn.

The Interstate Telephone Company has received the right of way through the township from the Greenwich Township Committee of New Jersey.

The plant of the Home Telephone Company in Gazette, N. J., will soon be sold under foreclosure of the mortgage bonds which the Interstate Telephone Company holds.

The wires of the Glen Telephone Company on West Fulton and Bleeker streets, in Gloversville, N. Y., will soon be placed under ground in conduits which are now being constructed.

The contracts covering all the services by the Western Union Telegraph Co. with the Baltimore & Ohio, Chesapeake & Ohio and Norfolk & Western Railways are said to have been renewed substantially on the old provisions.

The Southern Bell Telephone Company has estimated the cost of laying the conduits over certain streets of Montgomery, Ala., including the purchase of cables, at $100,000. Between $40,000 and $50,000 of this amount has already been expended.

The Watkins Telephone Company, in Watkins, N. Y., will soon begin the construction of a new telephone line there. This company was originally the New Century Telephone Company, of Cleveland. Over 300 subscribers are said to have been secured in Watkins.

Steps have been taken by prominent men of Bolivar, N. Y., for the formation of a local telephone company. As yet the organization has not been completed, but everything thus far is decidedly in its favor. It is expected that long-distance connections will be made at Wellsville through the toll lines of the Inter-Ocean Telephone and Telegraph Company. This will put Bolivar into communication with a large portion of the state and be a valuable service for the Bolivar merchants.

An arrangement has been concluded with the Western Maryland Telephone Company, of Carroll County, by the Maryland Telephone Company, of Baltimore, by which the lines of the two companies are to be connected. Work on the connecting line has already been commenced at three points. By this arrangement the patrons of the Western Maryland Company will be able to communicate by telephone with the subscribers of the Maryland company at Baltimore and *vice versa*.

The Independent Telephone Company at Wellsville, N. Y., under the management of Mr. H. W. Savidge, is reported to be steadily increasing its business. The farmers in the neighborhood of Wellsville are rapidly becoming educated to the value of the telephone, and it is expected that within a short time the territory in this neighborhood will be covered with farm lines. The line of the Inter-Ocean Telephone and Telegraph Company is now being rapidly extended west from Wellsville. It will connect with Wellsville, Belmont, Friendship, Cuba, Olean, Salamanca, Little Valley, Cattaraugus, Randolph and Jamestown and all intermediate points, with a view to giving a complete long-distance service for the western part of the state, particularly on points on the Erie Railroad.

ELECTRICAL SECURITIES

The general industrial situation has remained without much change during the past week. The money situation is somewhat easier, and the outlook in respect to finances quite satisfactory. In reviewing the situation the *Wall Street Journal* said: "The week brought an advance in the average price of 20 railway stocks from 106.20 to 109.48. Twelve industrials rose from 63.48 to 65.91. The advance was brought about by professional operators who saw opportunity for a turn on the short interest. They were helped by the increase in the Atchison dividend, and utilized various rumors in regard to railway deals. It is known that there are plans for some rearrangement of the Northern Pacific, Great Northern system, and, while they are not likely to mature immediately, enough is known of what is proposed to make a basis for rumor."

As the time approaches for the meeting of Congress, political questions are being discussed with more or less effect on financial operations. There seems to be considerable enthusiasm on the part of a number of the leading members of the Republican party over the scheme of reciprocity treaties with foreign nations; it is somewhat doubtful, however, if anything very tangible will be done this winter.

ELECTRICAL SECURITIES FOR WEEK ENDING OCTOBER 12.

New York:	Closing.
Brooklyn R. T.	60⅛
Con. Gas	216½
Gen. Elec.	254¾
Man. El.	119⅜
Met. St. Ry.	156
Kings Co. Elec.	195
N. Y. & N. J. Tel. Co.	165
Telep., Tel. & Cbl. Co.	6

Chicago, October 12:	Closing.
Chicago Edison Light	162
Central Union Telephone	45
Chicago Telep.	253
Un. Trac.	17
Un. Trac. pf.	58
Metropolitan El.	91⅝

At a meeting of the stockholders of the Central Union Telephone Company, the issued capital stock was reduced to $3,481,500, one-half of its present amount. There were no votes cast against the action. This action is in accordance with the plan adopted by the directors of the company to place the affairs of the company on a sound financial basis. It is understood that a subsequent meeting of the stockholders will be held to vote upon the question of increasing the stock of the company in order that money needed for the development of its business may be secured.

The Chicago Telephone Company paid a dividend of 3 per cent on October 9.

Boston, October 12:	Closing.
Am. Telep. & Tel.	159½
Erie Tel.	39
New Eng. Tel.	135
Mass. Elec. pf.	36
Westing. Mfg. pf.	72
Edison Elec.	250

The Edison Electric Illuminating Company, of Boston, has declared its regular quarterly dividend of 2½ per cent, payable November 1 to stockholders of record October 14.

Philadelphia, October 12:	Closing.
Elec. Co. of America	6⅛
Philadelphia Elec.	5¾
Union Traction	28½
United G. I. Co.	114
Elec. Stor. Bat. c.	63
Elec. Stor. Bat. pf.	63

LEGAL NOTES

OCCUPATION OF SIDEWALK WITH TELEPHONE MATERIAL NOT ADDITIONAL BURDEN UPON FEE—The occupation of a sidewalk with a trench and pipes for a conduit for telephone wires is held, in Voburn *vs.* New Telephone Company, Ind., 52 L. R. A. 671, not to be an additional burden upon the fee, which entitles the abutting owner to compensation, although it is laid so close to the line of the abutting property as to interfere with intended areas under the walk.

STREET RAILWAY COMPANY LIABLE FOR DEFECT IN STREET CAUSED BY PROJECTION OF RAILS—In Groves *vs.* Louisville Railway Company, Ky., 52 L. R. A. 448, a street railway company is held to be liable for a defect in a street caused by the projection of the rails, although they were originally properly laid, where the surface of the street has fallen away from them. The authorities on the question of the liability of a street railway company for defect in track or street are collated in a note to this case.

CONSOLIDATION OF STREET RAILWAY LINES NOT VIOLATION OF CONSTITUTIONAL PROVISION—It is held in Wood *vs.* Seattle, Wash., 52 L. R. A. 369, that the consolidation of street railway lines, authorized by ordinance because the public interests seem to demand it, is not in violation of a constitutional provision prohibiting monopolies, trusts and combinations of companies for the purposes of fixing prices, or limiting production, or regulating transportation of any product or commodity. A note to this case reviews the authorities on the right of corporations to consolidate.

TELEPHONE COMPANY LIABLE FOR ACCIDENTS CAUSED BY POLE WHICH SUPPORTS ITS WIRES—It is held in McGuire *vs.* Bell Telephone Company, N. Y., 52 L. R. A. 437, that a decayed pole which fell and injured a lineman in the employ of a telephone company, although it did not belong to it, but was used under a contract with its owner, it does not relieve the company from liability for injuries caused by the fall, if it had undertaken to make a special inspection of its poles, and the defective pole formed part of its permanent line, while the owner had made no agreement to maintain it securely.

MISCELLANEOUS

THE SPRAGUE ELECTRIC COMPANY recently held its annual meeting and re-elected the following officers for the ensuing year: John Markle, president; Edward C. Platt, first vice-president; Allan C. Bakewell, second vice-president; Harry R. Swartz, secretary and treasurer.

AT THE PAN-AMERICAN EXPOSITION one of the unique features is a log cabin snugly constructed in the clump of trees not far from the art gallery. This is a point of entertainment and is presided over by Rudolph Cermack, "steward of the log cabin." The Pan-American officials have found this a pleasant resting spot for odd moments and a place to take their distinguished visitors. The log cabin is an artistic edifice and is most comfortably furnished. Its contents are the gifts from the various friends of the directors and, from sandwiches to champagne, are free to all who have the *entree*. During the recent Edison convention in Buffalo several of the electrical officials visited the log cabin through the courtesy of Mr. Charles R. Huntley, of Buffalo, and Dr. W. M. Habirshaw, of New York.

PERSONAL MENTION

MR. FRANKLIN W. KOHLER, well known in electrical circles, has accepted the position of Chicago manager for the Milwaukee Electric Company, and is established in the Fisher Building.

MR. ANDREW CARNEGIE has offered to give $125,000 to the Glasgow Technical College toward the $200,000 necessary to complete the required fund of $750,000 for the improvement of that institution.

MR. O. L. REMINGTON, who is the Australian representative of the Diamond Meter Company, of Peoria, Ill., is making a tour of the United States looking up electric possibilities and developments in their relation to the trade.

MR. G. M. COLE, of Youngstown, Ohio, who is in charge of the work of constructing the new electric light and power station and the engineering work for the Youngstown & Sharon Street Railway Company, has returned from a trip to the East.

MR. JOHN H. FINNEY, late of Washington, D. C., has been appointed western sales manager of the Stanley Electric Manufacturing Company, with offices in the Monadnock Block, Chicago. Mr. V. W. Bergentnal, formerly of Pittsfield, Mass., will be engineer of the western sales office.

MR. H. C. ADAMS, JR., formerly secretary of the Phillips Insulated Wire Company, of Pawtucket, R. I., has resigned to accept the position of New York manager of the Peru Electric Manufacturing Company, of Peru, Ind. Mr. Adams is widely known in electrical circles and will assume his new duties November 1.

MESSRS. WALLACE D. LOVELL AND GENERAL MANAGER A. E. MACREEL, of the Exeter & Hampton Street Railway, have been in Portsmouth, N. H., regarding matters relating to the new electric light and power plant there. Mr. Lovell states that the work of constructing the plant will be begun very shortly.

MR. A. W. BRYANT, who is the consulting engineer of the Rhinelander Mutual Telephone Company, has been in Grand Rapids, Mich., inspecting the construction of the new system which is being placed in Grand Rapids. Mr. Bryant has nearly completed the exchange of the Rhinelander Mutual Telephone Company, which was formed last spring. This new exchange will have 250 telephones and cost about $14,000.

MR. JAMES FERGUSON, formerly general superintendent of the Municipal Electric Light Company, of Brooklyn, N. Y., and, after the amalgamation, superintendent of the Edison Electric Illuminating Company, has accepted the position of general superintendent and consulting engineer of the McRoy Clay Works, Brazil, Ind. Mr. Ferguson has for years been identified with the electrical interests of Brooklyn in all lines of construction and operation, and it is safe to say that he will handle the manufacture of McRoy conduits as capably as he has their installation.

AUTOMOBILE NOTE

A new use for motor cars has been discovered by Dr. Dawson Turner, who is vice-president of the Scottish Automobile Club. Dr. Turner thinks that the automobile has a great future in administering the open-air treatment to consumptive patients. He has been much impressed by the beneficial effects produced by a thirty to fifty-mile ride. By this ride the appetite is increased and the sleep improved and a healthy glow is heightened, which after a few days' treatment tends to become permanent. The tendency to cough is much diminished. The patient should be placed in the front of the car to avoid as much as possible the dust which is thrown up by the wheels.

INDUSTRIAL ITEMS

THE ELECTRIC APPLIANCE COMPANY, Chicago, is advertising Adams-Bagnall three and one-half ampere arc lamps for all circuits to meet gas or gasoline competition.

THE MONTAUK FIRE DETECTING WIRE COMPANY has just completed a fine installation of its wire in the Manhattan Theatre, Thirty-third street and Broadway, New York city.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, of Pittsburgh, Pa., is reported to have secured a substantial contract for the electric equipment of the shops of the Buenos Ayres & Rosario Railway.

THE CRESCENT MANUFACTURING COMPANY, 134 Van Buren street, Chicago, is placing on the market a cord spool which regulates the height of pendent incandescent lights, doing away with the loop in the arrangement, and simple enough to be used by anybody.

M. VICTOR DOURIN, 28 Rue de la Montagne, Bruxelles, Belgium, is in the market for all electric railway supplies and desires that catalogues of manufacturers be forwarded to him, particularly for commutators, armature coils and electrical supplies of a like nature.

THE BISHOP GUTTA PERCHA COMPANY is so occupied with its high and special insulations that it does not endeavor to compete for ordinary house wire, but it claims that the genuine rubber as used by it is not too good for cars and central stations. A specialty is made of extra flexible.

THE H. CHAUNON COMPANY, of Chicago, continues to find a ready demand for its Ajax transmission rope. The company claims that the material used and the method of manufacture make the Ajax the most powerful and economical rope for transmission of power in existence.

THE D. A. KUSEL TELEPHONE AND ELECTRIC COMPANY, St. Louis, has been obliged, on account of a gratifying increase in its business, to move into a larger factory building. The company is now located at 1119 Pine street, St. Louis. Mr. D. A. Kusel, head of the firm, is one of the pioneers in the telephone business.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, Mo., has recently gotten out a novelty in the medical battery line. It is a complete medical battery with all attachments, contained in an aluminum case seven inches long and two inches in diameter. It is very compact and can be easily carried in the pocket.

RUMSEY & SIKEMEIER COMPANY, St. Louis, which has recently added a complete electrical supply department to its hardware business, has found its present quarters too small. A large six-story brick and stone building on the corner of Nineteenth and Pine streets has been purchased by this firm, and will be occupied as soon as improvements can be made.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, of Chicago, reports a shipment of thirty-seven switchboards for the last week in September and the first week in October, thirteen of which were magneto and the remaining common battery boards. The shipment for Saturday, October 5, alone, was eight switchboards, five of which were magneto, and three common battery.

MR. I. P. FRINK, 551 Pearl street, New York, N. Y., reports a fresh importation of fine French silk and velvet flowers, used for decorative purposes on electric lamps. Mr. Frink has not been able to get any of these for some time, but now has a fine assortment of same on hand, in poppies, fleur de lis and roses, in a good variety of colors—all the delicate tints of old rose, pink, yellow, lavender, red, etc.

THE H. P. CAMERON ELECTRICAL MANUFACTURING COMPANY, formerly of Syracuse, N. Y., has established itself at Ansonia, Ct. This company announces that the change enables it to better serve its customers and that it is now equipped to furnish promptly assembled commutators, either new or refilled, armature coils, solid sheet mica and segments and pure copper commutator segments. It also has facilities for rewinding armatures and electrical machinery repairs.

THE UNITED STATES GEOLOGICAL SURVEY has prepared charts which show the mineral products of the United States from 1891 to 1900 inclusive. Any one desiring them may obtain them by addressing Mr. Charles D. Walcott, director of the Survey. This chart is issued in advance of the report on the mineral resources of the United States, 1900, which will be ready for distribution about November 1, copies of which may be obtained through a senator or representative in Congress.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, of Cincinnati, Ohio, has received a portion of the important contract for the electrical equipment on the Pacific coast of the Portland Cement Company's projected plant at Vancouver, British Columbia. The contract amounts to upward of $90,000, and calls for three 750-kilowatt generators for general power purposes and about 60 motors varying in size from seven and one-half horse-power to 150 horse-power. They are to be utilized for driving the machinery in the plant.

FRANK H. STEWART & COMPANY, of Philadelphia, Pa., is issuing a very attractive catalogue known as Catalogue No. 8, for the purpose of describing its electric household supplies, especially electric bells, electric gas lighting appliances, telephones, telegraph and speaking tubes. This company is prepared to make prompt shipments and carries a large and complete stock of all kinds of electrical supplies, such as batteries of many different types, many different kinds of electric bells, push-buttons, switches, burglar alarms, alarms with clock attachments, etc.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., has been awarded a gold medal by the Pan-American Exposition. This company placed an exchange on the grounds of the Pan-American Exposition for service between the officials and various buildings throughout the grounds. The plant was put in operation before the opening of the exposition and has given fine service continuously without interruption. It is said that the Stromberg-Carlson Telephone Manufacturing Company is manufacturing more than 100,000 instruments annually for large and small public exchanges.

CABLE TESTING APPARATUS FOR TELEPHONE COMPANIES—The larger telephone companies recognize the fact more fully than ever before that it is necessary to make frequent tests of insulation and capacity to determine whether their cable systems are in proper condition. Morris E. Leeds & Company, of Philadelphia, working in conjunction with Mr. Henry W. Fisher, of the Standard Underground Cable Company, Pittsburgh, have brought out a series of cable testing outfits that have been most highly prized by such telephone engineers as have had opportunity to use them. Recently Mr. James G. Biddle, of Philadelphia, who is sole selling agent for Morris E. Leeds & Company, took important orders for cable testing equipments from the Keystone Telephone Company, Philadelphia, and the Interstate Telephone Company, Trenton, N. J. The apparatus purchased by these companies is fully described in special catalogue 360, which can be obtained without charge by addressing Mr. Biddle.

NEW INCORPORATIONS

LEWISTON, PA.—Suburban Electric Company. $1,000.

TRENTON, N. J.—Watern River Electrical Company. $200,000.

BATAVIA, OHIO—Citizens' Telephone Company. $50,000.

LEWISTOWN, PA. — Granville Electric Light Company. $1,000.

REEDSVILLE, PA. — Reedsville Electric Light Company. $1,000.

CHATTANOOGA, TENN.—People's Light and Power Company. $200,000.

RIVERSIDE, CAL. — Riverside Power Company. $250,000. Directors: C. W. Rogers, J. H. Barbour and others.

CHICAGO, ILL.—Automobile Company of Illinois. $25,000. Incorporators: Joseph Grove, E. J. Hubbard and others.

TORONTO, OHIO—Leader Automobile and Engine Company. $25,000. Directors: S. E. Van Camp and W. J. Cummings.

SEATTLE, WASH.—Seattle City Railway Company. $500,000. Incorporators: James S. Goldsmith, Scott Calhoun and others.

ZANESVILLE, OHIO — The Zanesville Telephone and Telegraph Company has increased its capital stock from $200,000 to $250,000.

BISMARCK, N. D.—Bismarck Telephone and Electric Company. $100,000. To do a general telephone business. Incorporators: James Serne and others.

HAMILTON, OHIO—Hamilton, Eaton & Richmond Traction Company. $200,000. Mr. John J. Hall, of Dayton, Ohio, is the president of the company.

INDIANAPOLIS, IND. — Indianapolis, Shelbyville & Southeastern Traction Company. $600,000. Directors: Edward K. Adams, Thomas E. Goodrich and others.

ALBANY, N. Y.—Poughkeepsie Light, Heat and Power Company. $500,000. To manufacture gas and electricity. Directors: William B. Goodwin, Moses Ely and others.

SPRINGFIELD, ILL.—Oak Park Yaryan Company. $300,000. The men interested in the company are: E. A. Cummings, Charles E. Bolles, Willis S. Herrick and other citizens of Oak Park, Ill.

NEWARK, N. J.—The P. T. Motor Company. $100,000. To acquire, manufacture and construct boats and vehicles for carrying passengers and freight, and to deal in electric, compressed air, oil and gas motors.

UHRICHSVILLE, OHIO—The Uhrichsville, White City & Newcomerstown Railway Company. $10,000. To operate an electric railway through Uhrichsville, Gnadenhutten, Port Washington and Newcomerstown.

ALBANY, N. Y.—Westchester Traction Company. $200,000. To operate a street surface electric road from Ossining to Pleasantville, Westchester County, five miles. Directors: Thomas F. Barrett, Harry M. Shaw and others.

HARTFORD, CT. — Massachusetts Construction Company, Incorporated. $500,000. To construct, improve and equip electric, steam and other railroads, to deal in electrical and other supplies, machinery and equipment, drainage, water, gas, electric light, telephone, telegraphic and power plants and works. The articles provide that the corporation is not to operate railroads in Connecticut. The company is also empowered to acquire all or any part of the property, stock and business now or formerly owned by the Massachusetts Construction Company, incorporated under the laws of Massachusetts. Incorporators: Lucius F. Robinson, John T. Robinson and others.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED OCTOBER 8, 1901.

683,924 Electric elevator system; E. M. Fraser, San Francisco, Cal.—A car, two electric motors connected therewith in such a way that when they are both running at the same speed the car will remain stationary, and when they are running at relatively different rates of speed the car will move either upward or downward; a source of electrical energy, and means for short-circuiting the current through a portion of the field of either one of the motors.

683,927 Trolley switch device; F. W. Garrett, Johnstown, Pa.

683,936 Motor construction; G. H Hill, Glenridge, N. J.—A field-magnet, a yoke, a bolt supporting said magnet from said yoke, said yoke being slotted to receive said bolt.

683,952-953 Telephone transformer; Hans Liebreich, Detroit, Mich.—An instrument for increasing the efficiency of apparatus for transmitting electrical impulses, comprising one or more coils having a primary and secondary winding, a core located within the coil and secured therein so as to be free to vibrate at its ends, and means for connecting the coil with the transmitting line and instruments.

683,954 Telephone transformer; H. Liebreich, Detroit, Mich.

683,969 Telephone exchange system; W. E. McCormick, Chicago, Ill.

683,982 Incandescent lamp attachment; G. D. Pogue, St. Louis, Mo.—A dimming attachment for electric lamps, comprising an artificial resistance, a lamp-support, and means operable by engagement of a lamp with the support for cutting the resistance into the circuit of the lamp.

684,007 Circuit protector; A Stromberg, Chicago, Ill.—Two circuit terminals, a fuse stretched between the same, a third terminal arranged between the first-mentioned terminals and adjacent to the fuse, and a spring holding the fuse close to the intermediate terminal, but at a slight distance therefrom

684,014 Coin-actuated medical battery; N. M. Watson, Detroit, Mich

684,049 Plate-separating device for electrolytic tanks; E. G. Elliott, Perth Amboy, N. J.

684,083 Self-regulating system for electric light and power; M. Mosko-

(Continued on page 42)

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PATENTS.

(*Continued from page 41.*)

witz, Brooklyn, N. Y. A generator and electric circuit, a suitably magnetized exciter for the field-coils of the generator, an electric motor actuating the exciter and supplied from a constant source, and means for varying the field magnetism of the motor in correspondence with variations in the armature current of the generator.

684,090 Fuse-plug: C. D. Platt, Bridgeport, Ct.

684,092 Terminal for electric lamp-glowers; H. N. Potter, Gottingen, Germany.

684,093 Heater for electric lamp-glowers; H. N. Potter, Gottingen, Germany.

684,094 Heater cutout for electric lamps; H. N. Potter, Pittsburgh, Pa.

684,111 Telephone exchange system; C. E. Scribner, Chicago, Ill.

684,114 Switch for electric conductors; T. B. Shaffer, Westmoor, Pa.

684,165 Method of regulating electric circuits; M. H. Baker, New York, N. Y.

684,166-169 Regulating device for arc-lamp circuits; M. H. Baker, New York, N. Y.

684,188 Brush-holder; Jas. Burke, Berlin, Germany.

684,194 Signal for telephone trunk lines; H. M. Crank, New York, N. Y.

684,204 Reversible galvanic battery; T. A. Edison, Llewellyn Park, N. J.—An alkaline solution, a negative element, a positive electrode support of metallic magnesium, and a metal in solution, capable of being electro-deposited upon the magnesium, to constitute the positive electrode.

684,205 Reversible galvanic battery; T. A. Edison, Llewellyn Park, N. J.

684,222 Terminal for electric lamp-glowers; F. M. Goddard, Pittsburgh, Pa.

684,225 Electro-medical device; G. Graybill, York, Pa.

684,229 Glower for electric lamps; M. W. Hanks, Pittsburgh, Pa.

684,230 Glower terminal for electric incandescent lamps; M. W. Hanks, Pittsburgh, Pa.

684,255 Electric cable-hanger; G. W. Hughes, Philadelphia, Pa.

684,269 Electrical apparatus for body wear; J. Kornitzer, Socorro, N. Mex.

684,274 Automatic lighting system for telephone stations; F. E. Lister, Minneapolis, Minn.—A telephone and an electric lamp in the vicinity thereof, a source of electrical energy, with circuit connections including said lamp, a yieldingly closed circuit-breaker, and serving, when suspended thereby, to break said circuit and throw said lamp out of action.

684,289 Signal for telephone switching systems; F. R. McBerty, Evanston, Ill.

(*Concluded on page 44.*)

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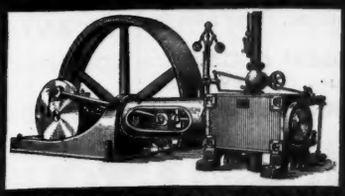

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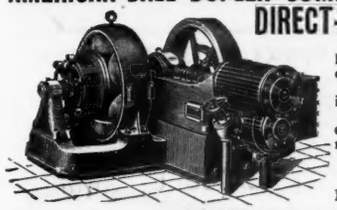

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2—60-kw Edison.

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1—50-kw Western Electric.
2—60-kw Edison.
2—45-kw Edison.
3—30 kw Edison.
5—25-kw Edison.
1—20-kw Edison.
1—50-kw Siemens & Halske.
1—30-kw Eddy, M.P.
1—25-kw M.P.-6 Excelsior.
1—22½-kw Westinghouse, M.P.
1—16-kw Lundell.
1—13½-kw American Ball (new).
1—12½-kw Kester, M.P.
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1—15-hp Mather.
1—10-hp M.P. Excelsior.
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1—25-hp Eddy, M. P.
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1—10-hp Mather.
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1—2 hp C & C.

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1—10-hp Eddy.
1—10-hp Thomson-Houston.
1—10-hp Lundell.
1—8-hp Excelsior.
1—7½-hp Lundell.
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1—2½-hp Fort Wayne.
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2—60-kw Westinghouse, single-phase, 16,000 alternations, 1100 volts.
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2—A-35 General Electric, single-phase, 16,000 alternations, 1050 volts.
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684,296 Electric furnace; W. Nernst, Gottingen, Germany.

684,303 Electric telephone system; W. E. Pembleton, Wittenberg, Wis.—An electric telephone system having the call-signal devices thereof in circuit with induction coils, electric resonators and talking-circuit conductors, together with means for generating current sufficient to cross the spark-gaps of resonators in a closed calling circuit.

684,315-316 Multiple switchboard system; C. E. Scribner, Chicago, Ill.

684,317 Telephone exchange apparatus; C. E. Scribner, Chicago, Ill.

684,326 Vacuum electrode for therapeutic purposes; R. H. Wappler, New York, N. Y.

684,332 Controller handle; E. A. Wildt, Scranton, Pa.

684,338 System of electrical distribution; H. J. Gille, St. Paul, Minn.

684,340-341 Regulating devices for arc lamp circuits; M. H. Baker, New York, N. Y.

684,342 Regulating device for arc lamp circuits; M. H. Baker, New York, N. Y.

684,351 Electrotherapeutic instrument; A. W. Courtney, Buffalo, N. Y.

684,366 Telephone exchange apparatus and circuit; George Grabe, Berlin, Germany.

684,376 Storage battery; L. W. Lombard, Boston, Mass.

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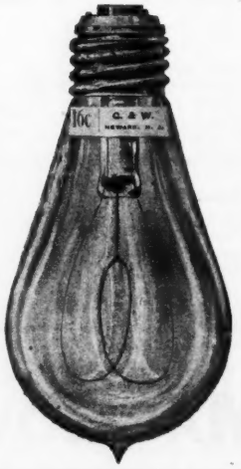

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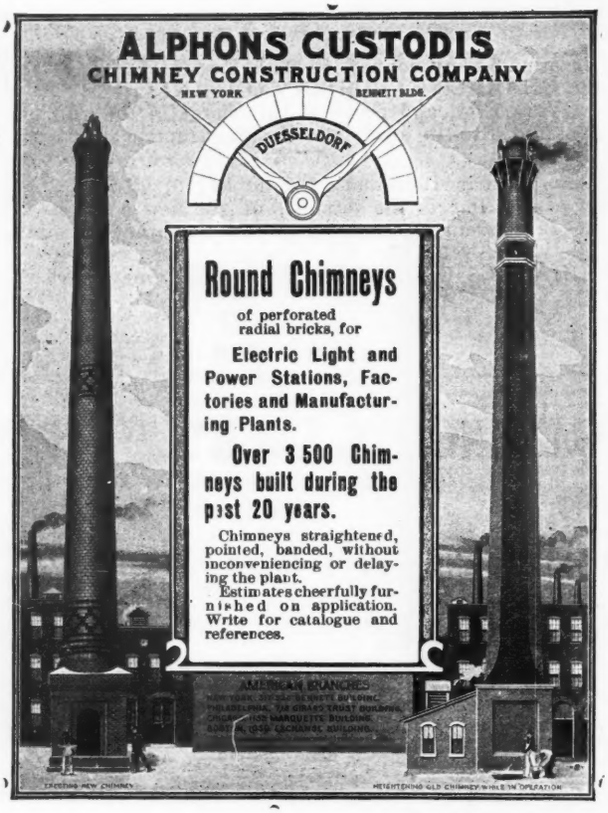
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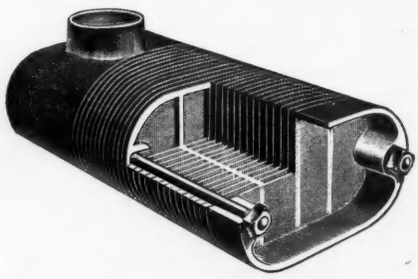

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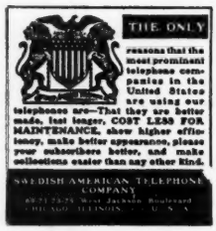
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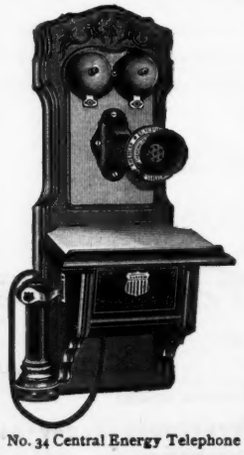

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